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An Audiometric Test for Young Children

HAROLD M. WILLIAMS¹

AS YET no adequate test of auditory acuity has been developed for use with young children. A satisfactory test for this purpose demands, in addition to the more general requirements of validity and exact control over the physical intensity of the stimulus, extreme simplicity of task, adequate motivation, and objectivity in the response required of the child. The whispering tests, while they represent a relatively valid measure of the actual functional efficiency of the ear, are lacking in control over the physical loudness of the sounds to such an extent that it is impossible to construct norms for the method, or to compare the work of different experimenters. The pure-tone tests, on the other hand, while they possess a high degree of control over the physical intensity of the sounds, are quite unsuitable for use with young children, on account of the intrinsically uninteresting character of the test, and the uncertainty of interpretation of the child's response.

The development of the Western Electric 4-A audiometer (1) has provided a technique which combines the

advantages of both types of test in a unique way. In this audiometer spoken numbers have been recorded at standard intensities on a phonograph disc, from which the sounds are picked up and transmitted electrically to a telephone receiver held to the ear. Relatively valid test sounds are therefore delivered to the ear under excellent conditions of physical control.

By the introduction of certain modifications of procedure in this technique, it is believed that the requirements outlined above for audiometric tests of young children have been successfully met.²

The test, which is necessarily given individually, has been converted into a "listening over the telephone" game. This change results in setting up a novel game situation which is easily grasped by the child and is well motivated. The first eight digits (the number seven being omitted) are used as test words. These are spoken singly, with an interval of four seconds between each number during which the child reports the number heard to the tester, who decides the correctness by an auxiliary receiver. The numbers are recorded on the disc in a

¹ The experimentation reported here was carried on while the writer was a National Research Council Fellow in Child Development at the Iowa Child Welfare Research Station.

² These modifications were incorporated in new phonograph records specially made through the courtesy of Dr. Harvey Fletcher of the Bell Telephone Laboratories, to whom grateful acknowledgment is made.

series of twelve levels descending in loudness, with two consecutive numbers at each level. The numbers in the first half of the test are spoken by a woman.

In the first trial record the directions were incorporated in the record. Further trial showed, however, that these directions were confusing to the younger children, so that they are now given by the tester. The preliminary directions are as follows: "I want to find out how well you can hear, so we are going to play a 'listening over the telephone' game. When you put this telephone receiver to your ear you will hear a lady saying some numbers. You are to listen carefully and tell me each time what she says. Ready!" The right ear is tested first. The first four numbers on the record are all of the maximum loudness and are used as a trial series to make sure that the child understands the directions and is responding satisfactorily. At the same time the tester makes the proper adjustments of the receiver to the ear. After the preliminary adjustments are made the tester now says, "Now you will hear some more numbers, but this time the lady's voice will get weaker and weaker. You must listen carefully so that you can tell me each number." The record is then run through until the child fails to report at least four consecutive numbers successfully. The directions then are, "Now we will try the left ear in just the same way as we tried the right ear." The inner half of the disc presents a similar series for use with the left ear. The obverse side of the record presents a similar series, spoken by a man.

Numbers were chosen as test materials after careful consideration of the situation for the following reasons. Children learn very easily to manipulate the first eight or more number names, even though the numbers as quantitative concepts may be quite meaningless to them. Even the three-year-old children tested showed no traces of unfamiliarity with the number names as words, although relatively few of them could count to eight independently. The Stanford Revision of the Binet scale (2) puts the repetition of three digits in the three year level, so that it is quite unlikely that the repetition of a single digit is in any way a task for the intelligence of the average child of this age. The narrowing of the field of choice to seven numbers makes the task of interpreting and recording the child's responses much simpler than if the words were chosen from the general field of common words, while still keeping the probability low that any child will get any number correct by chance.

While a spring support to hold the receiver against the ear would insure the greatest constancy of pressure, an actual tryout of such devices indicated that with many children they were a source of such great distraction and irritation that the test results were entirely invalidated. At present, therefore, the child is merely instructed to hold the receiver closely against his ear, the experimenter taking care to see that the hair is brushed well back, and that the receiver is held by the child with the opening of the cap directly opposite the meatus. Practically all the children tested



1c



1b



1a

FIG. 1. In a the numbers are clearly perceptible, in b fairly perceptible and in c they are completely below the threshold.

tended to press the receiver quite closely against the ear as the sounds became fainter.

The incidental remarks of the children tested have shown as a whole that they appreciated the situation and were entering into the spirit of the game. Such comments as, "Oh, her voice just gets so soft," were common. Nearly all of the children spontaneously remarked near the end of a series, "I can't hear her any more." Others, after listening intently said, "Why doesn't she say any more numbers?" The attitude in general, changed from one of great confidence and certainty, to one of increasingly greater uncertainty as the sounds became weaker. The new rush of interest which appeared when the man's voice was announced was an unexpectedly successful feature of the test. Illustrations of the motivation value of the test and of the change in attitude as the sounds became weaker are shown in the photographs in fig. 1, taken as the child was being given the test.

The tests are scored in terms of sensation units of hearing loss as is done with the former records. The test results are recorded on a blank form having divisions from 30 sensation units hearing loss to -3 units. On each level there will be 4 numbers for each ear. Due to the fact that lapses of attention, over-eagerness to make some remark about the "game" and so on are of common occurrence, many gaps will appear in the record of most children. For this reason considerable latitude must be allowed in the interpretation of the results, especially in the case of the younger children. The hearing level is there-

fore defined tentatively as the lowest level at which each child has 50 per cent of right responses.

The reliability of the test on 57 children, of age range four and one-half to six and one-half years, was .697, P.E. .05 by the method of chance halves. This would yield a reliability of .82 for the whole test. In ordinary routine testing, therefore, one applica-

TABLE 1
Distribution of scores on audiometer test

HEAR- ING LOSS	AGE							
	3-4 Years		4-5 Years		5-6 Years		6-7 Years	
	Right	Left	Right	Left	Right	Left	Right	Left
	Number of cases							
30								
27				1				
24		1						
21	1		1	2				
18	3		7	1	4			
15	2	2	3	4	2		1	
12	7	10	1	3	1	5		1
9	2	2	16	3	12	8	1	
6		1	5	10	11	6	12	2
3			2	9	1	11	3	11
0				2	1	4	2	4
-3					3	1	3	4
Num- ber..	16		35		35		22	

tion of the whole test is probably adequate for gross differentiation between normal and defective. The defective may be more intensively tested by repeating the record.

Table 1 summarizes the results by the scoring method recommended above on 108 children of age ranges, 3-4, 4-5, 5-6, and 6-7, from the pre-school laboratories of the Iowa Child Welfare Research Station and the first

grade of the University Elementary School.

These children were all normal or superior in intelligence. It will be noted that there is an increase in score from age group to age group. This may be interpreted in part as an increase in attentional power, but it is possible that there is a real increase in acuity during these ages. A few of the scores indicate serious impairment. In at least three cases observational evidence corroborated the findings of the test, although previous to the test no defect was suspected.

Where the necessary apparatus is available the test may be given with a record of constant intensity, the experimenter varying the loudness by

the attenuator of either the 2-A or 3-A Western Electric audiometer. A special record on which the numbers are all of maximal intensity is also available. This method has the advantage of making it possible for the experimenter to work down quickly to the critical level for each child, and to concentrate his efforts there. In the hands of a skillful tester who understands children it is believed that either technique will yield results which are far superior to current methods of testing acuity of very young children. Where the 4-A audiometer is already available the only additional expense which must be incurred is for the new phonograph records.

REFERENCES

- (1) FLETCHER, HARVEY: Some new methods and apparatus for testing acuity of hearing and their relation to the speech and tuning fork methods. *Laryngoscope*, 1925, 35, 501-524.
- (2) Terman, Lewis M.: The measurement of intelligence: An explanation of and a complete guide for the use of the Stanford revision and extension of the Binet-Simon intelligence scale. Boston, 1916, pp. xviii, 362.

A Study of Problem Solving Behavior in Pre-school Children¹

EUNICE MATHESON

PROBLEM

THE present study is an attempt to observe and analyze the problem solving activities of young children placed in situations similar to those employed by Köhler (9) in the experiment reported in *The Mentality of Apes*. The purpose of the study is not to make direct comparisons between the behavior of children and apes, nor to deal with the theoretical implications of gestalt psychology, but to get a general picture of the solving type of behavior in very young children by using Köhler's method of arousing activity of this kind.

History

In *The Mentality of Apes*, Köhler states the essential feature of his method by contrasting it with the maze experiment. He says, "American animal psychology makes animals

(or people) seek the way out of mazes, over the whole of which there is no general survey from any point inside; the first time they get out is, therefore, necessarily a matter of chance, and so for these scientists, the chief question is how experiences which have been made in such circumstances can be applied in further tests. In intelligence tests of the nature of our roundabout-way experiments, everything depends upon the situation being surveyable to the subject." He goes on, "Regarding their principle, I must make a further objection to Thorndike's experiments. They were designed as *intelligence tests* of the same type as our own (insight or not?), and ought, therefore, to have conformed to the same general conditions, and, above all, to have been arranged so as to be completely visible to the animals. For if essential portions of the experimental apparatus cannot be seen by the animals, how can they use their intelligence faculties in tackling the situation?" Therefore, Köhler uses situations "in which all the factors were given and the solution could be achieved," not situations in which the individual was dealing with things "merely thought about."

Köhler, besides reporting in his book the results of his work with the apes

¹ From the Department of Psychology and the Institute of Child Welfare, the University of Minnesota. The study has profited much by many helpful suggestions given by Dr. Edna F. Heidbreder, Dr. John E. Anderson, Dr. William T. Heron and Dr. Florence L. Goodenough. Thanks are also due the children of the Nursery School who acted as subjects in this experiment, and the principal, Dr. Josephine Curtis Foster, and teachers of the Nursery School for their cooperation.

at Tenerife, reports experiments on hens, a dog, and a small child in situations which demand a "round-about way" of solution. In the first place Köhler was trying to determine the intelligence level of the subjects with which he was working. The second aim in his work, he says, is theoretical. The fact that even the anthropoid apes are such a long way behind man, and yet "show so many human traits, makes it possible for us to study, under the simplest conditions, the nature of acts of intelligence." And "one may be allowed the expectation," he says, "that in the intelligent performances of anthropoid apes we may see in their plastic state once more processes with which we have become so familiar that we can no longer immediately recognize their original form; but which because of their very simplicity, we should treat as the logical starting point of theoretical speculation."

Köhler's principal conclusion was that the apes manifested "intelligent behavior of the general kind familiar in human beings," i.e., they were not limited to trial and error in dealing with problems. He reported that they sometimes displayed a type of behavior which he called "insight." He gave three criteria of insight, which may be stated in the form of questions: Is the achievement a single continuous occurrence,—a unity as it were in space and time, in which the individual parts have meaning only when considered in relation to the whole? Is the instant sharply marked in which the real solution begins by a kind of jerk, a sudden complete turning about, or a lighting up of the face of the

subject? Is the animal able to repeat the solution when placed in a similar situation, if a genuine solution has previously been used? The presence of behavior characterized by insight brought his work into contrast with that of Thorndike (12), Watson (13), and other American animal psychologists, who explained animal learning in terms of trial and error as opposed to insight.

Köhler himself suggested that his methods might be used in studying the behavior of young children. Although this suggestion was made some years ago, there have been, up to the present time, very few studies of this type made on human beings although both before and after Köhler's suggestion, there were many attempts to study the thinking or problem solving ability of human beings. Very little of it, however, has been of the type in which the individual was placed in a situation for which all the necessary material for solving was present. Helseth (7) observed and recorded the behavior of a group of seventh and eighth grade students in a history class, and tried to study and work out the lines of development in their thought processes. This was, of course, an experimental study, and yet it has very little direct bearing on this other type of study, for the tool which the pupils were using in that experiment was language and things thought about, rather than objects actually present. Piaget (10) has also studied the thought processes of the child, but his studies concerned themselves with the thinking processes of the child in connection with social situations. Philosophers have long

tried to work out logical analyses of the human thought processes, from the "recognition of the problem" to the consummation in "solution" and "verification." There are, however, a few studies in which human subjects have been placed in problem situations in which they were given the objective materials with which to work, and in which enough was explained so that they recognized the problem. Their behavior in the process of solution was then observed and studied. Studies of this sort have been made by Ruger (11), Heidbreder (7, 8, 9) and Duncker (2).

Comparative studies have also been made of the thought processes and concepts of primitive peoples and young children as opposed to those of civilized adults. Koffka (8) mentions the observations of Decroly and Degand, the Sterns, Major and Linder, and Wertheimer on this topic in his discussion of the dependence of thinking on the development of language.

Studies have also been made by Thorndike (12), Yerkes (14), Haggerty (3), and others, in which the behavior of animals has been studied in order to determine whether or not the term "insight" as used by Köhler may be applied to their reactions.

Two studies which have followed Köhler's suggestion very directly are those of Blatz and Alpert. Blatz has done some experimental work with young children, using situations as nearly similar as possible to those reported by Köhler. As yet only a preliminary survey has been published with regard to this work. Alpert (1), who placed children of the pre-school

level in situations similar to ones used by Köhler comes to the following conclusions:

1. "Exploration and elimination" is the most frequent type of behavior with children and also yields the greatest number of solutions.

2. Solution with gradual insight is perhaps the most frequent type among apes, whereas immediate is the most frequent for children.

3. Chance alone is ineffectual in problem situations of this type, but it may be instrumental in bringing about an optimum constellation of the elements, which may or may not arouse insight, but response culminates in solution only if subject has gained insight.

4. Transfer and retention seem to be indices of presence and degree of insight.

5. There is a low correlation of .266 between M. A. and achievement.

6. A child's solving activity is determined more by the nature of the problem situation than any one other factor.

7. The arousal of insight and its consummation in a practical solution are favored by emotional, temperamental and mental factors, in short, those factors which go to make up the total personality of the individual.

The present experiment, then, is the third which attempts to study the behavior of young children who have been placed in situations similar to those which Köhler placed his apes.

Method

In the experimental set-up the situations were objectively as similar as possible, both in general arrangements and details, to certain ones used and described by Köhler. Pre-school children, one by one, were placed in five selected situations, and the various types of reactions which were brought out were observed and

recorded in an attempt to study the problem solving activity at this age.

Subjects. The subjects were 28 children attending the nursery school which is conducted by the Institute of Child Welfare at the University of Minnesota. Considered as of January 1, 1929, they ranged in age from two years to four years six months, the mean C.A. being 41.3 months. For the purpose of considering age differences, the children were divided into three groups. The youngest group includes only three children between two and two and a half years. The eleven children spoken of as three-year-olds, ranged from two and one-half years to three and one-half years; the four-year-old group, ranged from three and one-half years to four and one-half years, and included fourteen children.

The mean I.Q. of the group of twenty-seven children was 115.1, and the mean M.A. 48 months. All but one of the I.Q.'s are based on Minnesota tests for pre-school children. This one exception is based on a Stanford-Binet. No. I.Q. has been obtained on one of the youngest children because of negativism and lack of responsiveness. The sexes are about evenly divided, but with relatively more boys in the upper age group. The children are selected for the nursery school so that the representation of the socio-economic classes is approximately the same as that in the population of the city at large.

General conditions. The experiment was conducted over a period of four months, beginning in January, 1929, and continuing through the month of April, 1929. The experi-

ment was carried on between 2:30 and 3:45 in the afternoons. The children began waking from their naps at 2:00 or before, and no child was taken to the experimental room immediately upon awaking, but was allowed to enter group activity or into some individual activity before the experimenter suggested to him that he go upstairs for a while, where there was something for him, or where there was a game for him to play.

In all the situations the child was to try to get a cookie. Since it was thought that the mid-afternoon lunch of milk and wafers or crackers might reduce the motivating value of the animal cookie the child was allowed but one wafer at lunch. Except in a few instances, the children were ready and eager to go with the experimenter. Often, when the experimenter was calling a child, another would ask "May I go today?" or "I know what she has for you, an animal cookie," or "Oh, I know a cookie, a cookie." It seemed to the writer that some of the children who were least eager to go were the ones who had recognized their own failure in a previous situation. This is perhaps only a generalization from a few noted cases since records on this point were not kept.

As was stated, the situations used were as similar in objective details as possible with certain ones used and described by Köhler.

Situation I. This situation was similar to the one Köhler describes in his introduction. A medium-sized black ring (two and one-half inches in diameter) hung in the middle of the ceiling. Through this a red string was drawn, which suspended a basket

containing an animal cookie. The basket was beyond the child's reach, at a distance of 5 feet 10 inches from the floor. The other end of the string was tied to a small black ring that was placed over a plain, right-angle hook, which was fastened in the wall two and one-half feet from the floor. The solution consisted in taking the ring off the hook and allowing the basket to fall to the floor, thus bringing the cookie within the child's reach. There was no other object in the room except a small box on which the experimenter sat while keeping the record.

Situation II. In this situation the basket hung from the middle of the ceiling at a distance of 5 feet 12 inches from the floor for all but the four smallest children, for whom it was lowered 4 inches. The string was fastened to the ring in the ceiling so that the basket could not be lowered. There were two boxes in the room, one against the right wall as the child entered the room and the other against the left. The box which was placed about half way along the right wall was 12 inches by 12 inches by 12 inches. The other was 12 inches by 16 inches by 20 inches. This situation was complicated, however, by placing the ring over the hook as in Situation I, but fastening the other end of the string to a small hook in the ceiling at a distance of 4 inches from the black ring from which the basket was suspended. This situation then, at the first glance, would appear somewhat similar to Situation I. The solution consisted in placing the smaller box on top of the larger one, climbing up and taking the cookie from the basket (9).

Situation III. For the next three situations, a railing 30 inches high, with spaces of $3\frac{1}{2}$ inches between the rails, divided the room into two equal parts, into one of which the door of the room opened. The child remained in the outer part and the goal was placed beyond the railing. In this situation a small box with a picture of an animal on it was placed 36 inches from the railing and opposite the middle of it. The box contained the usual animal cookie. Fastened to the box was a red string. The other end of the string just touched the railing. There were also four other strings, each of which touched the railing. These were placed in such positions that the correct string at the railing was the middle one of the five. The strings were placed in such a position that two "X's" and one straight line was formed (9). The solution consisted in choosing the correct string and pulling the box to the railing, where the child could get the cookie.

Situation IV. In this situation the same box as in Situation III was placed in a similar position except that it was only 33 inches from the railing. The tools given for solution were three sticks, 30 inches, 31 inches, and 35 inches in length, any one of which was long enough to reach the box. The sticks were irregularly placed on the child's side of the railing near the right hand wall. This situation was complicated by having the space between the box and the railing covered by the five strings, placed as in Situation III except that the box was separated from the end of the string which had been the correct one in that Situation, by a distance of $3\frac{1}{2}$

inches. The solution consisted in choosing any one of the sticks, putting it beyond the box and pulling the box to the railing, where the child could reach it and get the cookie.

Situation V. In this situation the box containing the cookie was placed at a distance of 33 inches from the railing near the right hand wall. A stick 14 inches long lay alongside the railing and opposite the box. Near the left wall, beyond the railing and out of reach of the children if they used their arms, a stick 35 inches long was placed parallel to the railing. The solution consisted in securing the long stick with the short stick and pulling the box to the railing as in Situation IV.

In all these situations an effort was made to have all the parts of the situation within the child's field of vision. This was particularly difficult with the young children, who, as Alpert says, often see only that which is on a level with their eyes, and do not look up nor down. Only with a few of the very small children was this difficulty found and in these cases the child was lifted by the experimenter until his eyes were on the level with the basket. Then he was put on the floor again and the routine procedure continued. It was thought better to lift the child up to the basket rather than to point to it, since the child might merely imitate the action. In most cases, however, the children saw the basket the moment they entered the room, or looked at it when the experimenter gave the first instruction.

Procedure. The cookie was placed in the basket or box before the child entered the room. Upon entering,

the child was given the following instructions: "There's an animal cookie in the basket (or box) for you, (name sometimes mentioned here). You get it and you may have it." No further directions were given or questions asked, such as might in any way aid the child to a solution. Questions regarding manner of solution or asking for help were not answered. If the child asked for *permission to do a specific thing*, the answer was "Yes," or "You may get it in any way you wish." "You get it" was sometimes repeated in the beginning, in order to make sure the child had understood the first directions. When the child had not tried, or had tried but without success, the experimenter used as a means of regaining the child's attention to the situation, or a means of motivation, "Do you know that John and Polly Ann and Dickie were up and got their cookies? Now you get yours." Before each trial was brought to a close and usually at the end of about five minutes, if the attempts of the child had been without success, or if he had not tried at all, the experimenter asked, "Would you like to go downstairs, or do you want to have the cookie?"—always in this order, so that the final suggestion in the child's mind was the cookie and not the going downstairs. If the child said he wanted the cookie, the experimenter said, "All right, you get it," and if he made further attempts he was permitted to go on for a short time, after which the experimenter said, "I guess we'll go downstairs now and try another day. Then I think you can get it."

Records. Records were kept on

blanks which gave a place for the date, the name of the subject, the situation, the length of time the child remained in the situation, a space for a running account of what both the experimenter and the child said, and also for a description of the total activity of the child.

Since it was the purpose of the experiment to get a general picture of problem solving behavior in young children, the first step in the treatment of the results was to note all the different kinds of overt reactions that occurred. It was found that these fell into the following fifteen categories:

Kinds of reactions observed

1. *Failure to Respond*: A group composed of three sub-groups.

- a. *Not responding*, (N. R.)²—No response to the problem situation, either for the entire time or for part of the time.

Examples: Subject looked at basket while first instructions were being given, but wanted to look at book. Subject went and played with door knob. Subject played with collar on dress; watched experimenter; then said, "I got a little dolly in my pocket."

- b. *Negativism*, (N.)—Cases characterized by stubborn unresponsiveness in behavior, lasting for a long enough period so that the records make the fact apparent.

Examples: Subject merely stood and looked at experimenter and sucked fingers. Showed no response to

instructions and did not answer the questions of the experimenter.

Subject looked around room, eyes on the floor, and did not look up at the basket. Subject did not in any way recognize experimenter's questions or instructions.

- c. *Leave situation*, (L. S.)—Cases in which the child said he wanted to leave the room.

Examples: Subject standing by door repeated several times, "I want to do downstairs."

Subject trying to open door, said, "I want to do out. I want to do out here. I want to do out. Where's my coat?"

2. *Feeling of Incapacity*, (Inc.)—Cases in which the child expressed or indicated a feeling that he could not meet the situation.

Examples: Subject went to railing, and at same time stepped on the sticks. He repeated, "I can't. I can't."

Subject said, "I can't get it. See, I can't get in here."

3. *Asking Experimenter for Help*, (E.)—Cases in which the child sought the aid of the experimenter.

Examples: Subject said, "Can I get a stick? Will you get the stick? Will you help me up there and then I can get it out? Put that pen in there and help me. Miss M., what are you writing?"

Subject said, "How can I get my cookie? Say, how can I get my cookie? How? How did they get theirs? How did they?"

4. *Sour Grapes or Rationalization*, (S. G. or R.)—Cases in which there was an attempt to explain away failure.

² The letters in parentheses are the abbreviations by which the categories are indicated in the tables.

Examples: Subject said, "But I don't care. I can have one at home. Say, I better try some other day. I don't care if they got theirs. I don't want a cookie. Why should I have one?"

Subject said, "I have to go home now. My mother wants me."

5. *Pointing or Reaching*, (P. or R.)—Cases in which the child pointed or reached or jumped toward the basket.

Examples: Subject said, "It's too high, isn't it? It's hanging in the ceiling," and at the same time reached toward basket.

Subject jumped and reached toward basket.

6. *Manipulation*, (M.)—Some overt manipulation in the direction of the object, or trying to get a tool, but not resulting in the correct solution.

Examples: Subject took ring off hook and pulled a little bit, but put it back over hook.

Subject moved one box under the basket and climbed onto it. Subject then jumped down and took ring off hook. Then he climbed back onto box.

7. *Other Solution Suggested*, (O. S. S.)—Cases in which the child suggested other possible solution, which did not apply in the given situation because tools were not available.

Examples: Subject said, "If there was only a box, then I could get up there," meaning over the railing.

Subject said, "If there was only a block here, then I could step. Maybe I can get a chair."

8. *Other Solution Used*, (O. S. U.)—Cases in which a solution was used other than the one expected by the experimenter.

Examples: Subject climbed over railing. Subject took ring off hook in situation where use of

boxes was correct solution. Subject then bumped basket with string and knocked cookie out of basket.

9. *Knowledge Without Solution*, (K. W. S.)

—Cases in which it was evident from action and conversation that the child knew the solution, but could not or would not carry it out.

Examples: Experimenter suspected that subject knew solution. After the particular situation had been brought to a close without the subject having solved the problem, the experimenter asked, "How do you suppose Bobbie got the Cookie?" Subject answered, "With the stick." Experimenter asked, "Which one?" Subject said, "That one," pointing at the long stick beyond the railing. Experimenter asked, "How do you suppose he got that?" Subject answered "With that," pointing at the short stick. Experimenter next asked, "Then how do you suppose he got the cookie?" and subject answered, "Put it back of the box," but when the experimenter said, "You show me how he did it," the subject answered, "I can't do it."

Subject in handling long stick moved the box a little beyond his reach before he started pulling it toward him. In order to test whether the subject really knew the correct solution, the subject was allowed to try again, and the second time he put the stick carefully beyond the box and pulled it to the railing.

10. *Partial Solution*, (P. S.)—A start in the right direction, which was not followed by a solution. If there was practically continuous manipulation up to time of solution, it was not tabulated as "P. S.", even though it was something that could have been tabulated as such if the solution had not resulted. However, if there was a partial solution, then a change to some other activity, such as "Inc.", "N. R." or "R" and later the solution did occur, the first was tabulated as "P. S."

Examples: Subject picked up short stick and reached toward box.

Subject turned large box on end and climbed onto it and reached toward basket.

11. *Surprise at Solution*, (S. at S.)—Cases in which child did not know solution would result from his act.

Examples: Subject took ring off hook; pulled basket to ceiling; hesitated. Subject then let go of ring. The basket fell to the floor. The subject came and stood by the experimenter and made sounds of surprise, and waited for the experimenter to tell him to get his cookie.

Subject took ring off hook; then merely let go, and the basket fell to the floor. Subject, rather surprised, said, "Look it. Where is that little round thing? Oh! up there. How can you get it up again?"

12. *Knowledge of Solution*, (K. S.)—Cases in which manipulation was followed by solution which child expected, as indicated by his comments or the behavior as recorded.

Examples: Subject after playing with ring and asking how to get the cookie, went back to ring, released it and held it while letting the basket lower and while getting her cookie.

Subject said, "Get that stick," after which she proceeded to get the long stick with the short one and use the long one correctly to get the cookie.

13. *Solution Without Preceding Manipulation*, (S. W.)—Cases in which the act began at once and with no unnecessary preliminary movements.

Examples: Subject reached right down and pulled correct string without touching others, and watched box coming. Subject said, "How can I get it?" paused a moment and said, "Maybe I can get it." Subject went immediately to long stick, pulled it to railing; picked it up and put it beyond cookie box and pulled it directly to railing.

14. *Solution for Sake of Solution*, (S. S.)—Cases in which the child repeated the essential activity of solution.

Examples: After subject had removed ring and let basket lower, pulled on ring until basket was again near the ceiling and then let it lower again before taking the cookie out, although he had looked at the cookie the first time the basket was lowered.

Subject put cookie basket as far back from the railing as possible and then repeated the act of pulling it to the railing.

15. *Miscellaneous*, (Mis.)—Special, exceptional and doubtful cases, such as those in which the subjects did not make use of the short stick in getting the long stick, but pulled the long stick to them with their feet; also cases in which the experimenter felt the subject knew the solution, but had not direct positive evidence.

TABULATION OF THE DATA

In tabulating the data, the writer went through the records for each

child and noted each kind of response which a particular situation had elicited from the child. This meant that no type of response was counted more than once for the same child in a single situation. This procedure avoided the difficulty of deciding how many specific times a given reaction appeared. For example, it would have been difficult to decide *how many* times a child showed negativism during the course of a problem, or how *many times* a tabulation should be made for "Manipulation" during a

considered functions of the particular features of any particular situation, but may be regarded as general modes of activity brought out by situations of this type. Responses connected with solutions form an exception to this general rule. Since each problem demanded a particular performance for its solution, the reaction closely associated with the solution would, of course, be determined by the special features in each case. For example:

Situation I brought out no instances of "other solution used," since no other solu-

TABLE 1
Table showing all of the responses according to situations

SITUATION	AVERAGE TIME	N. R.	N.	L. S.	INC.	E.	S. G. OR R.	P. OR R.	M.	O. S. S.	O. S. U.	K. W. S.	P. S.	R. AT S.	K. S.	S. W.	S. S.	MIS.
I	5'03"	11	2	3	17	11	4	11	11	4	0	0	1	4	6	1	2	7
II	7'34"	8	2	4	16	12	4	9	19	3	2	3	8	0	6	0	1	3
III	4'20"	5	1	3	16	13	1	2	21	5	2	0	1	0	10	2	0	2
IV	4'08"	3	1	2	15	14	2	5	23	3	3	1	1	0	10	0	1	5
V	4'08"	6	1	5	10	10	3	3	19	3	3	2	5	0	7	2	1	7
Total number responses..		33	7	17	74	60	14	30	93	18	10	6	16	4	39	5	5	24
Per cent responses..		23.6	5.0	12.1	52.9	42.9	10.0	21.4	66.4	12.9	7.1	4.3	11.4	2.9	27.9	3.6	3.6	17.1

given test situation, though the occurrence of negativism or manipulation to some degree were clearly apparent.

Responses in relation to the situations eliciting them

Table 1 shows the distribution of responses according to the situations which elicited them. The first fact which becomes apparent is that every situation brought out every kind of response, with the exception of those directly connected with the solution. The responses, therefore, cannot be

tion than the correct one was possible in this situation.

Only Situation I brought out instances of "surprise at solution."

No cases of "knowledge without solution" appeared in Situations I or III; i.e., no child who knew the correct solution in the case of removing the ring from the hook and letting the basket lower, or in the case of pulling the cookie box to the railing by means of the string, failed to do so.

Partial solutions occurred with greatest frequency in Situations II and V, those in which the correct solution involved either the large and the small box, or the short and the long stick, thus making it possible to solve the problem part by part. It is

interesting to note that this kind of activity is similar to the "partial analysis" which Ruger found to be so frequent in his adult subjects.

The largest frequency of solutions occurs in the category "knowledge of solution," i.e., solution following manipulation, in which the child knew the solution was coming. Ruger also found this sort of thing in his adult subjects.

The table also gives information concerning the *relative frequencies* of the different responses brought out by the different situations.

The largest percentage of instances out of the total number possible occurs in the category "manipulation," this kind of response having occurred in 66.4 per cent of the cases. If we combine the categories "manipulation" and "pointing or reaching" to determine how many times a response occurred of a general sort which might be called "trial and error," i.e., if we tabulate but once for each child situation in which either one or both of these kinds of responses occur, the percentage is raised to 77.1. The prominent rôle of trial and error is thus clearly indicated.

The next two largest percentages occur in the categories "feeling of incapacity" and "seeking help from experimenter." Again there is a similarity to the results of other studies. Ruger says that feelings of inability to solve puzzles were frequently mentioned by his subjects in the early stages of the experiment. The large number of cases in the second category, "seeking help from experimenter," is probably due to the fact that all the children used were very young. Heidbreder found that young children were much more likely than adults to respond to the social element of the situation, and that seeking help from the experimenter was one of the reactions in this class.

If we combine all the sub-groups under "failure to respond," i.e., if we tabulate but once for each child in each situation in which one or more of the various types of "failure to respond" occurs, we see that this

response appears in 51 (36.42 per cent) of the cases.

There were 48 solutions in the experiment as a whole. This represents 34 per cent of the possible number of solutions. Out of these solutions, 39 cases came in the category "knowledge of solution," all of which followed manipulation. Solutions in the category "solution without preliminary manipulation" were rare. In the whole experiment there were only five cases of this sort. It was solutions of this kind in which Köhler was particularly interested, and it is interesting to note that this represents a very small percentage of the total number of solutions, when an attempt is made to keep a record of all the reactions made.

Responses in relation to the individuals studied

In table 2 the responses are classified according to the children from whom they were elicited. According to this table, no child showed responses of all though some children showed a greater variety of responses than others. This does not mean however, that variability of response is greater from the standpoint of situation than from the standpoint of individuals. Each child was tried out in only five situations; whereas each situation was tried out with 28 children. The wider range of response elicited by each situation may easily be due to this fact. If each child had been placed in a greater number of situations, the range of his responses would probably have been wider.

However, there are some kinds of responses common to nearly all of the

TABLE 2

Table showing all the responses made by each child in the five situations

CHILD	AVERAGE TIME	N. R.	N.	L. S.	INC.	R.	S. G. OR R.	P. OR R	M.	O. S. S.	O. S. U.	E. W. S.	P. S.	S. AT S.	E. S.	S. W.	S. S.	MS.
1	2'	2				1			1						1	2		1
2						1			4				1		3			2
3		1				3			2		2				1			
4		3				2		3	3				1					2
5						3	3	1	5	2	2	1		1	1			
6		1				3	1		4				1	1	3	1	1	
7						4	4	3	5	2		1	1		5		1	2
8		1		1		5	1	1	1				1					
9		1				22		1	5	1	1		1	1	3			2
10			1			3	2		3			1			1			2
11						2	2	2	1	4	1				1			1
12				1		5	4	1	2	5	2	2	2		2			2
13		2	3						1									
14		2				4	3	1	3				2					2
15		1				2	3	2	3	5	2	1			2			2
16		4		2					2	2			1					
17				2		2	4	2	2	2	3							
18		1		4		5	1		2	4	1							
19		1		4		5	2	1	2	4	1		1					
20		4	1	2														
21		4		1		5	4	2	3	3								
22		2	2			1	4		1	3			1		2	1		1
23						2	3		1	5					5			1
24		2				3	4		3	5			2		1			
25		1				5			2	2								1
26						5	4	1	1	3	1	2			1	1		1
27						2	4		5				1	1	4			1
28						2	4		4		1		1		3	1	2	1
Total...		33	7	17	74	60	14	30	93	18	10	6	16	4	39	5	5	24
		17	4	8	23	21	10	16	27	11	6	5	13	4	17	4	4	16
		60.7	14.3	28.6	82.1	75.0	35.7	57.1	96.4	39.3	21.4	17.9	46.4	14.3	60.7	14.3	14.3	57.1

children. The relative frequency of the number of children from whom the response was elicited is as follows:

"Manipulation" was shown by all but one child, or by 96.42 per cent of the children. Some type or other of the "failure to respond" group was shown by 74 per cent of the children. "Incapacity" was shown by 82.14 per cent of the children. "Seeking

help from the experimenter" was a response shown by 75 per cent of the children. Cases of "knowledge of solution," in which manipulation was followed by solution which the child knew was coming, appeared among 60.71 per cent of the children.

Though these numbers cannot be taken in an absolute sense, they indicate that these children had strong

tendencies to reaction in some way when placed in this type of situation. There was but one child who consistently showed only one kind of response, and that was found in the "failure to respond" group of categories. This child consistently responded to something other than the problem.

Relation between age and responsiveness to problems as such

The data were also analyzed to see whether there was any relation between age and responsiveness to a problem as such. This question has been considered by Heidbreder (7, 8,

responses were likely to occur at particular age levels, in order to determine the extent to which the child was responding to the problem.

The percentage of each response was computed for each age group by dividing the actual number of times the response occurred by the possible number of times it might have occurred. In getting the percentages in the case of the "sour grapes or rationalization," the procedure varied a little, as the number of times the response occurred was not divided by the number of times it might have occurred, but by the number of times in which failure occurred at each age

TABLE 3

Table showing percentage distribution of responses mentioned in relation to chronological age

C. A.	NUMBER OF CASES	N. R.	E.	INC.	MAN.	P. OR R.	O. S. S.	S. G. OR R.
2 year olds.	3	100	6.6	33	47	27	6.6	0
3 year olds.	11	40	33	60	56	20	9	12
4 year olds.	14	20	59	51	79	21	17	25
Correlations with C. A.		-.74	+.64		+.44	-.03	+.35	

9) who noted that responsiveness to a problem as such rarely occurred below the four-year-old age level.

In order to bring out the evidence on this point the categories of "failure to respond," "asking experimenter for help," "feelings of incapacity," "pointing or reaching," "manipulation," "rationalization or sour grapes," and "other solutions suggested," were studied. These categories include all kinds of responses noted except those having to do directly with the kinds of solution. Those having to do with solution will be taken up later in a separate discussion. These categories were studied to see whether particular

level, in order to determine the percentage of cases in which the children rationalized their feelings. The results are presented in table 3. Correlations were also computed between these responses and C. A.

Failure to respond. All the cases under the "failure to respond" were considered together in this part of the analysis. When the percentages are computed for the different age levels, it becomes evident that there is a constant decrease in the percentage with increasing age. At age two the percentage coming under this category is 100. This does not mean that "failure to respond" represents the

total activity of the child, but that for as least a part of the time, or in some of the cases the whole time, the child was not responding to the problem situation as such. At age three the percentage of cases in this category is 40; and at age four it drops to 20, showing that with age there is an increase in responsiveness to this type of situation, and it appears that the most distinct break comes between the ages two and three. However, the number of cases at age two is too small to warrant generalizing. The correlation between chronological age and "failure to respond" is $-.738 \pm .058$.

Asking experimenter for help. Another line of evidence pointing to this increase in responsiveness with age comes from a consideration of the cases tabulated under "asking experimenter for help." At age two there was but one response out of a possible 15, or $6\frac{2}{3}$ per cent listed under this category. At age three the percentage increases to 33, and at age four to 59. It is, therefore, not the youngest children who ask most often for help or information with regard to manner of solution. It appears that there must first be a certain amount of responsiveness to the problem situation as such, before the need for assistance is felt. The correlation between chronological age and "asking experimenter for help" is $+.642 \pm .075$.

Feelings of Incapacity. A third line of evidence comes from a consideration of the number of responses of a feeling of "incapacity." At age four 51 per cent of the possible responses are listed under this category. At age three the percentage is 60, and at

age two the percentage is 33. A possible explanation of the fact that the percentage does not go up between ages three and four is that the four-year-olds were able to solve more of the problems, and this would eliminate the feelings of "incapacity" somewhat, although a feeling of "incapacity" was often followed later with a solution.

Pointing or reaching. When we consider the category "pointing or reaching," we find but slight age differences and those not consistent. At age two the percentage of responses appearing in this category is 27; at age three the percentage is 20; and at age four the percentage is 21. The four-year-olds are just about as apt to reach or point at the object or goal as are the two-year-olds. The correlation between chronological age and "pointing or reaching" is $-.026 \pm .127$.

Manipulation. When the category "manipulation," in which the child is overtly manipulating objects, is considered, however, we have a definite increase with age. The cases in this category at age two are but 47 per cent of the number possible. At age three it is raised to 56 per cent, and at age four to 79 per cent. The correlation between chronological age and "manipulation" is $+.435 \pm .103$. It is interesting to note that this correlation is lower than the correlation between chronological age and "asking the experimenter for help." This is due to the fact that the tendency to manipulate was fairly strong even in the lowest age group, whereas "asking the experimenter for help" was much less common at the lower age levels.

Sour grapes and rationalization. At

age two, where there were no solutions, there was no attempt at rationalization and no response of the sour grapes variety. At age three, where there were fourteen solutions and forty-one failures, there were five cases of "rationalization and sour grapes" or 12 per cent of the cases of failure. At age four, where there were thirty-four successes and thirty-six failures, there were nine cases of "rationalization and sour grapes" or 25 per cent of the cases of failure. Apparently the children become more concerned about their failures; or no doubt, there may be a constant increase in the number of recognitions of failure as such, for in the cases where there is failure to respond to the problem situation, there is also, no doubt, a corresponding failure to recognize the failure to solve the problem.

Other solutions suggested. Other solutions than the particular one which was expected for a given situation were suggested in 17 per cent of the cases at age four, in only 9 per cent of the cases at age three, and 6.6 per cent of the cases at age two, showing an increase with age in the number of solutions suggested by the situation even though the necessary tools might be lacking. The correlation between chronological age and number of "other solutions suggested" is $+.345 \pm .112$.

On the whole, then, there is evidence of an increase with age of responsiveness to a problem as such. Reactions included in the "failure to respond" group of categories steadily decrease in relative frequency with increase in the age of the groups, while "manipulation" and "seeking help" which

imply a direct reaction to the problem itself, show an increase. "Feelings of incapacity" and rationalization do not occur at the lowest age level, where indications of responsiveness to a problem are almost entirely lacking, but are most frequent at the ages where the subjects show signs of recognizing the problem, but are not as yet able to solve it. The correlations range from $-.74 \pm .07$ between chronological age and "failure to respond" to $+.64 \pm .17$ between chronological age and "asking the experimenter for help."

Relations between age and the ability to solve problems

The question of whether the ability to solve problems is related to maturity was also considered. The question was answered by noting the distributions of solutions at different age levels (both chronological age and mental age), and by noting the correlations between age and solutions. The distributions are given in table 4.

From the standpoint of C.A. the results are very clear. There is a definite increase with age in the number of solutions per child. At age two the average number per child is 0; no child under two and one-half years of age solved any problem. At age three the average number of solutions per child is 1.3, and at age four is 2.4.

From the standpoint of M.A. the results are at first less clear. When M.A. is considered, age groups are less clearly defined, for the range covered is from twenty-seven months to seventy-eight months, and when this is divided into age groups, there

is but one child under two and one-half years, and he makes no solution; there are nine children between two and one-half and three and one-half with an average number of solutions per child of 1.5; ten children between three and one-half and four and one-half with an average number of solutions per child of 2.1; five children between four and one-half and five and one-half with an average number of solutions per child of 1.4; two children between five and one-half and six and one-half, (one of them being five years-seven months and the other exactly six years six

child is capable of solving the situation as set up by the experimenter, but on the other hand, they do lessen the possible chances that the child has of solving all five situations. These cases were taken into account by subtracting them from the number of solutions occurring as compared with the number possible. A correction was also made for "knowledge without solution." It was considered equivalent to solution, because the question in this particular connection was whether the child knew how to solve the problem and not whether he actually

TABLE 4

Table showing distribution of solutions according to C. A. and M. A. by average number and percentage

C. A.				M. A.			
C. A.	Number of cases	Average number per child	Percentage	M. A.	Number of cases	Average number per child	Percentage
2 year olds	3	0	0	2 year olds	1	0	0
3 year olds	11	1.3	26	3 year olds	0	1.5	30
4 year olds	14	2.4	62	4 year olds	10	2.1	47
				5 year olds	5	1.4	45
				6 year olds	2	3.5	88

months), with an average number of solutions per child of 3.5.

However, an inspection of the raw data suggested that the average number of solutions per child does not present a very accurate picture, for it does not take into account the cases coming under the categories "other solution used" and "knowledge without solution." Failure to consider cases in the category "other solution used" distort the results because these cases have no chance of being included in the average number of solutions, since they do not tell anything about whether or not the

went through the motions. A percentage distribution of solutions according to the M.A. groups worked out on this basis follows:

MENTAL AGE	SOLUTIONS per cent
Under 2½ years	0
2½-3½ years	30
3½-4½ years	47
4½-5½ years	45
5½-6½ years	88

There is a very slight difference in the reverse direction between the four year group and the five year group,

but the series as a whole indicates a consistent tread.

When the same changes are made in tabulation, i.e., when the categories, "other solutions used" and "knowledge without solution" are treated in the manner described, C.A. differences are also brought out more clearly. A percentage distribution of solutions according to C.A. groups worked out on this basis follows:

AGE	SOLUTIONS
	per cent
Under 2½ years.....	0
2½-3½ years.....	26
3½-4½ years.....	62

This shows an even greater age difference than when we considered merely the average number of actual solutions per child.

The same trend of relationship between ability to solve problems and age is shown by correlations between solutions and mental age. The correlations between solution (including cases of "knowledge without solution") and chronological age is $+ .464 \pm .1$ and between solution (including cases of "knowledge without solution") and M.A. is $+ .422 \pm .107$. In summary, then it may be said that there is a positive and significant relationship between the ability to solve problems and both M.A. and C.A.

Transfer from one situation to another

One of the criteria which Köhler uses to distinguish between intelligent and unintelligent behavior is the reaction of the subject when, at a later time, he is placed in a situation which he has solved. If he has solved

the situation through "insight," he will immediately produce the correct reaction; if he has solved it by trial and error, the correct reaction will not appear immediately.

It was not possible to make exactly this test in this experiment, but an approximation was attempted. For example, Situation II was made similar to Situation I in that in Situation II, when the child reached the basket by climbing on boxes, the ring and string by which the basket could be lowered in Situation I were also present, but the string was not attached to the basket. The question was whether in solving the first problem the child had merely reacted to the ring on the hook because it was the only object in the room to which he could react with manipulation or whether he would immediately try to use the same procedure in the second situation. Had the child understood why the method he had used in Situation I had brought about the solution?

In the case of Situation I, eleven of the 28 children removed the ring from the hook, two others looked at the ring and one played with the string. Of the eleven who removed the ring in Situation I, ten removed it when placed in Situation II. The one child who did not, but who had done so in Situation I watched the basket carefully when he moved the string a trifle, and said, after talking about using the boxes, "I just did that other one to take that down, (pointing at the ring). That won't work this time." Of the ten individuals who removed the ring in both situations, eight continued to pull hard, jerked hard on the string, or else asked the

experimenter why the cookie did not come down this time. One of the two who did not react in this manner put the ring back immediately, giving no reason for doing so, while the other child explained during the situation why it did not work. The latter child had shown "surprise at solution" in Situation I, but had also shown a marked interest in why the solution had been brought about. After removing the ring the second time in Situation II, and observing at the same time, "It doesn't come down. It's not fastened onto the basket there you see," and after succeeding in getting the cookie by the use of the two boxes, this child said, "I climbed up and got it. Is that why you had the boxes? I know because you didn't have the string fastened."

Only two children who had not removed the ring in Situation I did so in Situation II. One of these had merely looked at the ring in Situation I, and in Situation II put it back immediately after removing it. The other child who had expressed only negativism during the first situation played with the ring and let it swing this time. One child who had looked at the ring in Situation I took hold of the ring but did not remove it in Situation II. Two children who had neither touched nor looked at the ring in Situation I touched the ring but did not remove it. The child who merely played with the string in Situation I, paid no attention to the ring or string in Situation II.

There is evidence, therefore, for three statements: (1) that ten of the 11 children who solved Situation I did so without complete understand-

ing, since they applied the solution uncritically in a situation changed in a crucial manner and (2) that one of the solutions had been made with an understanding sufficiently clear to enable the child to offer spontaneously an explanation of the change in his procedure, and (3) that one child who had shown "surprise at the solution" in Situation I was able to explain what had been changed when placed in Situation II.

Situations III and IV were also somewhat similar. In fact Situation IV resembled Situation III in all respects except that none of the strings were attached to the box and that the sticks were present. Thirteen children solved Situation III, five of them pulling only the correct string. Of these 13 children, ten pulled or moved one or more of the strings in Situation IV; one looked at the strings only and then immediately solved the problem with the stick; another looked at the strings, said, "I am going to pull this, but I can't get it," (indicating the cookie), but did not touch any of the strings, and later said, "I pulled that string once and got it, but it won't come today," and the other one of the thirteen children did not even look at the strings. The two who merely looked at the strings in Situation IV had been ones who had pulled only the correct string in Situation III.

Of the ten children mentioned as doing something with the strings in Situation IV, one merely pushed all the strings away, but did not pull any; another said after looking closely, "How can I get the string?" but took hold of the two strings opposite the

basket and pulled a trifle; another said, "Is there any string on it?" pulled two of the strings, looked a while then pulled two more and played with all of them; another pulled each string a trifle, watching the box at the same time and then said, "I guess I can't get it;" another pulled three of the strings and then said, "Oh, I can't. How can you pull it?" three of them pulled the strings but said nothing about it; while another asked where he should pull or reach his cookie and tried to get one of the strings back to the box so that he could pull the box to him, saying, "guess I'll pull it by a string. Then I can get it out;" and the other one of the ten said, "How can you? There isn't any string on it," but went ahead and pulled one string anyway, and then said, "How can we get it? The string broke."

This last child who was able to explain why the box would not come, and the child, who though he did not touch the strings in this Situation, explained, "I pulled that string once and got it, but it won't come today," are the same two respectively, who in Situation II explained that the problem could not be solved by releasing the ring although that had been the correct solution in Situation I.

Of the children who did nothing with the strings in Situation III, two of them pulled a string out in Situation IV, one of these merely playing with it and trying to poke it through the key hole; and a third touched all five strings but did not pull any of them. The rest of the children paid no attention whatsoever to the strings.

Judging from these results there was evidently more understanding in

Situation III than there had been in Situation I. In general, the behavior of the children who had solved Situation III showed two features when presented with Situation IV: (1) a tendency to carry over the manipulation of the string to a new situation in which it appeared, and (2) a tendency to suspect that the old solution would not work, even when they used it.

It is especially interesting to note that these results indicate that the understanding of a situation exists in *degrees* and that the complete understanding which Köhler characterizes as insight represents one extreme of the distribution, when all cases are considered. Ruger and Miss Alpert also found that understanding or "analysis" or "insight" existed in various degrees of completeness.

DISCUSSION AND CONCLUSIONS

The experimental procedure used in this study places a number of difficulties in the way of interpretation. There are several factors which cannot be controlled. Interest, motivation, and general attitude cannot be held constant from child to child even when they are of the same age, and when comparisons are attempted between children and adults and between human beings and animals, the matter becomes even more difficult. Besides, individual differences in past experience and in inherited natures operate in cases of this sort, and cannot be equalized.

It is difficult, too, to follow and interpret correctly the problem solving activities even of adults, who in addition to their overt behavior, give verbal accounts of their activities. It is even more difficult to follow the

activities of children, since cues are more limited, and interpretations must be based on their overt activity plus a few chance remarks which occur seldom and when they do give only meager explanations of their activity.

Results from studies such as these, as yet at least, cannot be measured in any definite manner or by any yardstick of values. The study is thus limited to the device of simple enumeration. Decision as to categories was based on the experimenter's judgment, subjectivity being guarded against by immediately and as fully as possible making a record of what the child did and said, by defining the categories as objectively as possible, and by using only the words of the subject or activity which seemed readily understandable to determine in which category the behavior should be listed. A possible way to determine the objectivity of tabulation is to give the data which has been collected and the list of categories with the definitions to a group of judges, and ask them to tabulate it, and then determine the degree of agreement between judges. This was not done in this experiment because it was impossible to secure enough judges to examine all the data. However, one person besides the experimenter examined the data and disagreement was found only with regard to two categories, those being "P.S." and "C.S.S." The results, therefore, merely represent general tendencies.

SUMMARY

1. Every situation used in the experiment called out a wide range of responses. Every kind of response observed occurred in all the situations,

with the exception of responses directly connected with solutions and these were often directly determined by the concrete features of the particular situation. The responses as a whole, however, may be considered a function of the general type of situation presented, not of the particular situation.

2. The responses which occurred most frequently were those classified as "manipulation," and "pointing and reaching." The prominence of trial and error in the problem solving of children is indicated by this fact, since the categories "manipulation" and "pointing and reaching" include the reactions usually called trial and error.

3. The responses which ranked next in frequency were those classified as "feelings of incapacity" and "asking the experimenter for help." "Feelings of incapacity" did not always indicate inability to meet the situation; they were often followed by trial and error and sometimes by solution. "Asking the experimenter for help" occurred principally in children who responded actively to the problem, not in those who made no attempt at solution.

4. Individuals varied in the range of responses elicited by the situations, but some type of problem solving behavior was elicited from every child, with one exception, by at least one of the situations. From most of the children, solving activities of some sort were elicited by all the situations. The percentage of cases, when all children and all situations are considered, in which only "failure to respond" was recorded, was but 10.7.

5. A positive relationship was found between chronological age and responsiveness to a problem as such.

This is indicated by the fact that the number of problem solving reactions increased with age and the number of failures to respond decreased with age. "Pointing or reaching" was the only type of response observed which did not show a definite increase or decrease with age. This positive relationship is also indicated by marked positive correlations between chronological age and "manipulation," "asking experimenter for help," and "other solutions suggested," and a marked negative correlation between chronological age and "failure to respond."

6. The ability to solve problems was positively correlated with both mental and chronological age. This is shown by the fact that the number of

solutions increases with both chronological and mental age, and that statistically significant positive correlations are obtained between the number of solutions and both chronological and mental age.

7. Solutions were of various sorts, "solutions at which the child showed surprise," "manipulation followed by solution which the child knew was coming," and "solutions which occurred without preliminary manipulation." Solutions of this latter sort, which according to Köhler showed "insight" occurred, but were rare. The results of this study are in harmony with those of Ruger and Alpert in indicating that understanding of the solution of a problem may exist in various degrees.

REFERENCES

- (1) ALPERT, A.: The solving of problem situation by pre-school children. Teachers College Contributions to Education, 1928, No. 323.
- (2) DUNCKER, K.: A qualitative (experimental and theoretical) study of productive thinking (solving comprehensive problems). *Ped. Sem.*, 1926, 33, 642-708.
- (3) HAGGERTY, M. E.: Imitation in monkeys. *Jour. Comp. Neur. and Psychol.*, 1909, 19, 337.
- (4) HEIDBREDER, E. F.: An experimental study of thinking. *Arch. of Psychol.*, 1924, No. 73.
- (5) HEIDBREDER, E. F.: Problem solving in children and adults. *Ped. Sem. and Jour. Gen. Psychol.*, 1928, 35, 522-545.
- (6) HEIDBREDER, E. F.: Reasons used in solving problems. *Jour. Exper. Psychol.*, 1927, 10, No. 5, 397-414.
- (7) HELSETH, I. A.: Children's thinking. A study of the thinking done by a group of grade children when encouraged to ask questions about United States history. Bureau of Publications, Teachers College Columbia University. 1926.
- (8) KOFFKA, K.: The growth of the mind. New York, 1924, Harcourt, Brace.
- (9) KÖHLER, W.: The mentality of apes. New York, 1925, Harcourt, Brace.
- (10) PIAGET, J.: Language and thought of the child. New York, 1926, Harcourt, Brace.
- (11) RUGER, H. A.: The psychology of efficiency. An experimental study of the processes involved in the solving of mechanical puzzles and in the acquisition of skill in their manipulation. *Columbia Contributions to Philosophy and Psychology*, 1910, 19, No. 2.
- (12) THORNDIKE, E. L.: Animal intelligence. *Experimental studies*. New York, 1911, Macmillan.
- (13) WATSON, J. B.: Behaviorism, an introduction to comparative psychology. New York, 1914, Henry Holt.
- (14) YERKES, R. M.: The mind of a gorilla. *Genet. Psychol. Mono.*, 1926-1927, 1 and 2.

A Comparative Study of Visual Apprehension in Nursery School Children and Adults¹

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PURPOSE OF THE PRESENT INVESTIGATION

THE number of separate items which can be apprehended and reported from briefly exposed material presented either simultaneously or serially may probably best be termed the "span of visual apprehension." A compilation of experimental results obtained with adults as subjects shows that the span of visual apprehension varies with (1) the method of scoring employed, (2) the completeness of the report demanded from the subjects, (3) the length of the series exposed, (4) the duration of the exposure, (5) the color or brightness of the stimuli, (6) the amount of practice of the subjects, and (7) the nature of the stimulus material. These results have been summarized by Tinker (7).

Interest in the effect of age upon perceptual span and in the relation between this span and reading ability has led to a considerable amount of research on school children. Two

principal conclusions would seem to be substantiated by a survey of these investigations. First, the length of the span is positively correlated with chronological age and second, the length of the span is positively correlated with measures of general mental ability.

Since, however, none of these previous investigations used subjects younger than about six years (first grade pupils), questions such as the following suggested themselves. What would be the perceptual span for a group of pre-school children? How would it correlate with chronological and mental age? More fundamentally, would a test of visual apprehension yield reliable and valid scores at this early age level?

Uniform motivation is particularly difficult to obtain at the pre-school level. Apparently, the best plan is to make the task as intrinsically interesting as possible in the hope that when each is doing what he enjoys, all are about equally motivated. In accordance with these considerations, then, toys were selected as being the type of stimulus material most likely to be of interest to young children, and thus likely to yield the truest or most valid measure of their perceptual span. On the further

¹ From the Psychological Laboratories, the University of Minnesota. The writer wishes to acknowledge her indebtedness to Dr. Miles A. Tinker under whose direction this problem was completed and to Dr. John E. Anderson and Dr. Josephine C. Foster for permission to test children enrolled in the Minnesota Nursery School.

assumption that different types of toys might possess different degrees of interest value and that these differences would be revealed in the responses, it was decided to use two main classes of stimuli, first, toy animals, and second, toys other than animals. It also seemed desirable to test a group of adults under conditions as nearly like those used with children as possible and to compare the performances of the two groups.

The purpose of the present investigation, then, is fourfold: (1) To determine the span of visual apprehension for toys among pre-school children and the relation between this span and measures of maturity. (2) To determine the part contributed respectively by the apprehension of toy animals and by the apprehension of toys other than animals, to a total score in visual apprehension. (3) To compare the performance of a group of adults on this test of visual apprehension with that of young children on the same test. (4) To determine the feasibility of testing span of visual apprehension at the pre-school level.

SUBJECTS IN THE EXPERIMENT

Two groups of subjects were used in the experiment. The first consisted of 30 children attending the nursery school conducted by the Institute of Child Welfare at the University of Minnesota. Fifteen of them were boys and fifteen were girls. Information was obtained from the nursery school records on the occupation of each child's parent and the classification of that occupation according to the Barr-Taussig scale (in which Class I is described as "professional;" Class

II, as "managerial;" Class III, as "clerical;" Class IV, "skilled labor;" Class V, "semi-skilled labor;" Class VI, "unskilled labor"). In comparison with the distribution of occupations in the city of Minneapolis as a whole, this small group contained a disproportionate representation from the upper two classes at the expense of the lower ones. The mean chronological age of the 15 boys at the time of taking the visual apprehension tests was 47.0 months with a range from 36 to 58 months, and the mean age of the girls was 47.3 months with a range from 34 to 58 months. The I. Q. for each child was obtained from records on file in the nursery school. For the boys, the mean I. Q. was 114.9 (range 84-131), and for the girls, 112.2 (range 92-128). Assuming constancy of the I. Q., a mental age was determined for each child by multiplying his chronological age at the time of the visual apprehension tests by his I. Q. The average mental age of the boys was 53.4 months (range 43.9-69.6) and of the girls was 53.0 months (range 38.1-71.5).

The second group of subjects was composed of 30 University of Minnesota students, 15 men and 15 women. About one-third of them were graduate students in psychology.

APPARATUS AND METHOD

The essential feature of the exposure apparatus built for this experiment was a vertical frame supporting an ordinary window shade with the ratchet on the spring held back so that when a retaining cord was released, the curtain would roll up revealing the stimulus material spread out on

a table top.² A low table placed to the left of the apparatus contained all the toys used as stimuli. A vertical cardboard screen, $4\frac{1}{2}$ feet high, parallel to the left side of the apparatus, concealed these toys from the subject. The examiner stood behind this screen, a position from which she could easily operate the cord controlling the curtain, transfer toys from the table at the left to the exposure table, and watch the child to see that he maintained continuous fixation on the toys for the duration of the exposure.

A preliminary survey using as subjects seven of the two-year-olds in the nursery school yielded 11 animals and 12 inanimate objects suitable for use with children. The toys were all of approximately the same size, about 5 inches long, $2\frac{1}{4}$ inches wide, and 5 inches high on the average.

With children, six items (three animals and three inanimate objects) were placed on the table for each exposure, and in the total of 50 trials, each toy was used approximately the same number of times. Grouping of the toys on the exposure table varied from trial to trial. No object appearing in the first exposure was shown again before the fourth, none in the second appeared again before the fifth, etc.

For testing adults, 14 animals and 13 inanimate objects were added to those used with children. In an

endeavor to have a situation which would be relatively as difficult for the older subjects as was six items per exposure for children, it was decided that for adult testing each exposure should contain ten objects (five animals and five inanimate objects).

For both groups of subjects, the duration of the exposure was three seconds. All tests were administered individually in a small, well lighted room containing nothing but the apparatus used in this experiment.

Several aspects of the testing procedure, made necessary by the extreme youth of the subjects, seem worthy of enumeration. (1) To minimize fatigue, the 50 trials given each subject were administered in short series of ten trials on each of five different days. (2) Each child was given an opportunity to name all of the toys before each day's testing. (3) Practice trials sufficient in number to teach each child his part of the "game" preceded the experimental series of exposures. (4) The child was allowed to play with a toy while the experimenter was changing the stimuli for the next trial.

Adults were tested in two sittings of 25 trials each. At the beginning of each day's testing, the subjects were asked to name over all the objects on the table. They were handed written instructions, and had one practice trial before the first group of 25 trials, but none before the second series. Each trial was preceded by the usual signals, "Ready!"—"Now!" and then, after an interval of about $1\frac{1}{2}$ seconds, the exposure was given.

Both children and adults gave their responses orally and immediately at the conclusion of the exposure, naming

² A complete description of the apparatus, the stimulus material, and the method used in this investigation, as well as the detailed results are given in the Master's thesis (1930) of the same title on file in the library of the University of Minnesota.

as many of the objects as they could remember. Scoring was in terms of the number of items correctly reproduced per trial.

DISCUSSION OF RESULTS

Three scores were computed for each person tested, (1) the average number of items correctly named per trial, (2) the standard deviation of the 50 scores on the separate trials of the experiment, and (3) the coefficient of variation $\left(\frac{\sigma_{\text{dist}}}{\text{mean}}\right)$. These data are presented in table 1 which is to be read

is slightly under two items, and data presented in column 3 of the table shows that here, as has usually been found, there are wide individual differences in perceptual span. The average span for the group of 30 adults was 6.17 items, almost exactly what Whipple (5, 6) found for three adults using very similar stimulus material and a six second exposure. The average span for his group was 6.07 items.

The amount and the statistical significance of the differences between the averages found for children and

TABLE 1

The distributions and means of three visual apprehension scores for the various groups of subjects tested

GROUP	NUMBER	AVERAGE SPANS			STANDARD DEVIATIONS			COEFFICIENTS OF VARIABILITY		
		Mean	$\sigma_{\text{dist.}}$	Range	Mean	$\sigma_{\text{dist.}}$	Range	Mean	$\sigma_{\text{dist.}}$	Range
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Boys.....	15	1.960	0.662	1.10-3.32	0.813	0.165	0.500-1.150	0.446	0.119	0.239-0.719
Girls.....	15	1.873	0.461	1.04-2.84	0.899	0.112	0.747-1.150	0.515	0.110	0.363-0.718
All children....	30	1.919	0.572	1.04-3.32	0.856	0.145	0.500-1.150	0.480	0.119	0.239-0.719
Adults.....	30	6.17	0.686	4.82-7.26	1.210	0.152	0.87-1.55	0.197	0.026	0.160-0.256

as follows: Column 1 gives the central tendency of the average perceptual spans for the various sub-groups; column 2 presents the standard deviation of the distribution of these averages for each group; and column 3 shows the range of spans within each group. Similar summaries are presented in columns 4, 5, and 6, for the measures of absolute variability (standard deviations) and in columns 7, 8, and 9 for the scores in relative variability (coefficients of variability).

Inspection of table 1 reveals that for the group of 30 children, the average span of visual apprehension

those found for adults in the three visual apprehension scores are presented below:

$$\begin{aligned} \text{Mean} \dots \dots D &= +4.25 & \frac{D}{\sigma_D} &= 27.21 \\ \text{S. D.} \dots \dots D &= +0.372 & \frac{D}{\sigma_D} &= 8.77 \\ V \left(\frac{\text{S.D.}}{\text{Mean}} \right) \dots D &= -0.272 & \frac{D}{\sigma_D} &= 13.20 \end{aligned}$$

In length of span and in amount of absolute variability averages for adults (as is indicated by the plus sign preceding the difference) are significantly larger than those for children. In relative variability, however, children

exceed adults. The significantly larger perceptual span for the adult group falls in line with previous work which has shown that the greater the difference in age between two groups, the greater will be the difference in span of visual apprehension favoring the older group. That the children are relatively more variable than the adults probably means that factors influencing the perceptual span on a test of this sort, such as interest, motivation, attention, and understanding of directions remain more constant from trial to trial in an adult than they do in a young child.

A matter of paramount interest in the present investigation was the reliability with which the technique used was measuring the span of visual apprehension. Two split-scale reliability coefficients were computed for each group of subjects. Individual scores for the odd-even reliability coefficients were determined by totaling separately the number of objects correctly reproduced on the 25 odd-numbered trials and the number correct on the 25 even-numbered trials. The second reliability coefficient was a correlation between total scores on the first 25 trials and total scores on the second 25 trials. Both coefficients were raised by the Brown Spearman formula to show the probable reliability of the test as a whole. These reliability coefficients are presented below:

Children (Odd-Even)	$r = .91, r_x = .96$
Adults (Odd-Even)	$r = .85, r_x = .92$
Children (1st vs. 2nd half)	$r = .84, r_x = .91$
Adults (1st vs. 2nd half)	$r = .70, r_x = .82$

All of the coefficients are high enough to justify group comparisons. Reliability coefficients are higher for children than for adults, a function, very likely, of the relatively greater range of individual differences among the younger subjects. Because these individual differences were found to be highly correlated with chronological age, it seemed desirable to attempt to determine what the odd-even reliability would have been had the group been more homogeneous with respect to age. To this end, the children were divided into two smaller groups, the first a group of 16 four-year-olds whose actual ages ranged from 48 to 59 months, and the second, a group of 14 entitled "three-year-olds" whose actual age range was from 34 to 47 months. The odd-even reliability coefficients for these smaller groups appear below:

Age 4	$N = 16, r = .71, r_x = .83$
Age 3	$N = 14, r = .89, r_x = .94$

These coefficients are of respectable magnitude, particularly in the younger group. The method is open to the criticism that we have not really achieved homogeneous age groups since one year at this level represents a relatively wide range of ages. The small number of cases, however, prohibited any further sub-division. Furthermore, selecting two groups which are at least less heterogeneous in age than the total group, gives us reliability coefficients which are somewhat lower than the original one. We may, therefore, assume that our first reliabilities are higher than we could expect to obtain from testing individuals all of the same age.

To measure practice effect on this test, the *total scores* computed for the first 25 trials and second 25 trials separately were averaged for the whole group. Results from this treatment of the data appear in table 2. The group of adults showed an improvement which amounts to a little less than one item in terms of average span. This is slightly greater than the amount of gain found by Whipple (5, 6), during a practice period of 27 exposures for each kind of material. Volunteered introspections from many of the subjects would seem to substantiate the same reasons for the improvement as those arrived at by

TABLE 2

Reliability of the differences between scores on the first and second halves of the visual apprehension test

	1st 25 TRIALS	2nd 25 TRIALS	DIFFER- ENCE	$\frac{D}{\sigma D}$
Adults.	146.70	161.80	+15.10	6.29
Children.	49.40	45.23	-4.17	2.71

Whipple, i.e., habituation to the experiment, familiarity with the material, and development of tricks of grouping.

The children, however, not only failed to gain but actually showed a lower average total score for the second 25 trials than for the first 25. There are 99.7 chances in 100 that a repetition of the experiment on a similarly selected group would result in a difference in the same direction. Apparently, boredom and fatigue are likely with young children to counterbalance any possible effect of practice on the later trials of a long continued experiment. This conclusion receives

some substantiation from remarks frequently made by the children on the last days of testing.

In view of the high odd-even reliability obtained for this group of children, an interesting possibility suggested itself. If we had given just 30 trials instead of 50, would we still have measured each child's performance reliably? The odd-even reliability coefficient based on the first 30 trials alone was $.86 \pm .03$ and raised by the Brown-Spearman formula became $.92 \pm .02$. The corresponding coefficients based on 50 trials were .91 and .96. If, then, we are interested only in group comparisons, 30 trials per child gives us a reliability high enough to make predictions safe. If, however, we are interested in individual prediction, we had better use 50 trials. But are we increasing reliability at the expense of validity in this longer experiment? Presumably the best possible performance of an individual who is maximally motivated is the performance with which we are concerned. If interest, and with it motivation drops off markedly in the later trials of an experiment, then possibly an average based on fewer trials would be the higher, and thus the truer, measure of an individual's ability. To throw some light on this point, an average span for each child based on the first 30 trials alone was computed. These measures were averaged for the group as before. The mean of the new average spans was 1.96 items as compared with the original mean of 1.92 items. The difference between these two averages is small and not statistically significant when considered in relation to its

standard error $\left(\frac{D}{\sigma_D} = 1.62\right)$. A correlation of $+ .97$ between average spans based on 30 trials and those based on 50 trials indicates that for locating a given child's position within the group, either average is equally good.

The effect of age on span of visual apprehension is shown by a comparison of the average perceptual span for the 16 four-year-olds, 2.26 objects, with the average for 14 three-year-olds, 1.54 objects. The difference here indicated is 4.41 times its standard error and is in line with results found by other investigators. The best picture of the relation between maturity and span of visual apprehension is given by the correlations between these two variables, which appear below:

Apprehension score vs. C.A. = $+ .84$ $\pm .04$
Apprehension score vs. M.A. = $+ .72$ $\pm .06$
Relative variability vs. C.A. = $- .69$ $\pm .06$
Relative variability vs. M.A. = $- .72$ $\pm .06$

The correlation between total score in visual apprehension and C.A. is very much higher than any reported previously, even though the other investigators reporting correlations (Payne and Dallenbach) had a range in chronological age exceeding the range in this study. Dallenbach's (1) correlation between visual apprehension and C.A. was $+ .19$, and Payne's (4) was about $+ .15$. The correlation of $+ .72$ with mental age (see above) is of about the same magnitude as similar correlations, discovered by Dallenbach (2) for his group of feeble-minded

subjects, and by Hoffman (3) for grade school children when familiar words formed the stimulus material in the visual apprehension experiments. Much lower correlations are reported by Hoffman when the stimulus material was unrelated consonants, and by Payne (4) for both digits and words.

The last two correlations, between measures of maturity and relative variability, indicate that the older the child, or the higher his mental level, the more closely his scores on individual trials tend to cluster about his mean score.

Table 3 shows that the group of adults correctly reproduced more of the

TABLE 3

The reliability of the differences between the number of animals and the number of inanimate objects correctly reproduced by children and adults

	INANIMATE OBJECT SCORE	TOY ANI- MALS SCORE	DIFFER- ENCE	$\frac{D}{\sigma D}$
Adults.	164.50	144.1	20.4	6.04
Children.	39.03	56.93	17.9	6.07

objects which were not animals than they did of the animals. The difference between the averages is 6.04 times its sigma and is thus reliably established. The explanation of this difference would seem to lie in the fact that the inanimate objects selected as stimuli were all common and familiar objects. The toy animals, on the other hand were difficult to procure, and in order to obtain a list of 25 all of the correct size, many of the less familiar ones (giraffe, camel, etc.) had to be included. This resulted in a real difference in the speed

with which they could be apprehended and named and the corresponding ease with which they could be remembered. Very few of the adults tested failed to volunteer observations substantiating this conclusion. The children, however, show a difference equally significant in the opposite direction. Clearly the same explanation cannot obtain here. As a matter of fact, the preliminary drill in naming the toys which preceded each day's testing revealed that for children, as for adults, the inanimate objects, as a group, were more familiar than the animals. It seems to the author that the factor operative at the pre-school level was a real difference in the interest and attention value of the two classes of stimuli with the animals holding the advantage.

SUMMARY AND CONCLUSIONS

1. The primary aims of the present investigation were to determine the span of visual apprehension among pre-school children and the feasibility of testing this function at this early age, to discover the relationship between this span and measures of maturity, to compare the performance of pre-school children with that of adults on the same test of visual apprehension, and to determine the relative parts contributed to a total score in visual apprehension by the reproductions of two types of stimuli.

2. Subjects used in the experiment were 30 children from the nursery school conducted by the Institute of Child Welfare at the University of Minnesota, and 30 students in the University of Minnesota.

3. The technique of the investiga-

tion was, briefly, to expose a number of toys for three seconds in an especially constructed exposure apparatus and then to ask the subjects to name all they could remember of what they had seen.

4. Split-scale reliability coefficients were all high enough to justify group comparisons.

5. Although performance on this test shows a significantly high correlation with age, reducing the age range to approximately one year by dividing the children into an older and a younger group, does not materially lower the odd-even reliability of the test.

6. The average span of visual apprehension obtained for the pre-school children acting as subjects in this experiment was 1.919 items. The average span for the adults tested was 6.17 items.

7. As a group, the adults show significantly greater absolute variability about their respective averages than do the children, but relatively, the children are much more variable.

8. Comparing total score on the first 25 trials with total score on the last 25 trials shows a slight practice effect for adults and a slight loss for children, the latter being due presumably to a decrease of interest in the "game" as the experiment continued.

9. Correct reproduction of the inanimate objects exposed contributes a significantly larger amount to the total scores made by adults than does the naming of animals. The difference appears to be due to the greater familiarity of the inanimate objects. For the pre-school children tested, the difference is equally significant

but in the opposite direction, and is attributed to the greater intrinsic interest or attention value of the animals as stimuli.

10. For children, the total score on this test of visual apprehension correlates $\pm .838 \pm .04$ with chronological

age and $-.724 \pm .06$ with mental age, thus demonstrating the predominant importance of maturity factors in determining the span of visual apprehension. Relative variability on the test correlates $-.690 \pm .06$ with C.A. and $-.725 \pm .06$ with M.A.

REFERENCES

- (1) DALLENBACH, K. M.: The effect of practice upon visual apprehension in school children. *J. Educ. Psychol.*, 1914, 5, 321-324; 387-404.
- (2) DALLENBACH, K. M.: The effect of practice upon visual apprehension in the feeble-minded. *J. Educ. Psychol.*, 1919, 10, 61-82.
- (3) HOFFMAN, J.: Experimentelle psychologische Untersuchungen ueber Leseleistungen von Schulkindern. *Arch. f. d. ges. Psychol.*, 1927, 58, 325-388.
- (4) PAYNE, C. S.: The derivation of tentative norms for short exposures in reading. Harvard Univ. Press, 1929.
- (5) WHIFFLE, G. M.: The effect of practice upon the range of visual attention and of visual apprehension. *J. Educ. Psychol.*, 1910, 1, 249-262.
- (6) WHIFFLE, G. M.: Manual of mental and physical tests. Part I: Simpler processes. Baltimore, 1914, 262-296.
- (7) TINKER, M. A.: Visual apprehension and perception in reading. *Psychol. Bull.*, 1929, 26, 223-240.

The Influence of Training on the Vocal Ability of Three-Year-Old Children

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THE present investigation was designed to measure the singing ability of three year old children and to study the effects of training on the child's vocal performance.*

Initial measurements were made of the child's ability to reproduce pitch, by the singing of separate tones, and his ability to reproduce intervals, by singing of two successive tones of different pitch. Training in singing was given to a group of children during a

period of several months, while an equivalent control group was tested at the beginning and at the end of the investigation. A study was also made of the children's spontaneous vocalizations.

The study offers findings with regard to such factors as the notes and intervals which can most readily be sung by three year old children, individual differences in performance, and the influence of training on vocal performance. The data furthermore provide findings with regard to the relationship between children's vocal abilities and such factors as ability to learn the melodies and words of songs, general intelligence, parents' vocal range, and the range and content of spontaneous singing.

Forty-eight children, ranging in age from 31 months to 48 months, were used in the study. Eighteen of these were given training twice weekly during a period of six months. The 18 children completed a total of 40 practice periods required for each child.

The children who were not included in the training series were tested early in the study, and as many as could be found were retested at the end of the experiment. From their number 18 were selected to serve as a control group. Each child in this group was

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paired, as closely as possible, with respect to age and score on the initial tests, with a child in the group that completed the training series. The control group was used to find the degree to which the improvement exhibited by the trained group could be attributed to such factors as growth, increased familiarity with the procedure, more favorable rapport with the experimenter, and other incidental conditions rather than to actual increase in vocal ability through training.

References to published and unpublished experimental work in music can be found in the Twenty-eighth Year Book of the National Society for the Study of Education (6). References to the valuable studies conducted at the University of Iowa prior to and including the year 1928 are given by Seashore (4). The authors are not aware of published experimental results dealing with the main problems of the present study.

PROCEDURE

Tests of pitch and interval

The first step in the study was to find the number of notes and intervals which each child could sing. Two tests, which will hereafter be designated *pitch* and *interval*, were designed for this purpose.

The initial pitch test included the following 11 notes, beginning with Middle C:

C D E F G A B C D E F

The initial interval test included the following 12 intervals: Ascending and descending major and minor seconds

and thirds, perfect fourths and perfect fifths.

When the pitch and interval tests were given, the children were taken in groups of two or three to a separate room and were seated at a table, facing the experimenter. They were encouraged to play on a small xylophone and permitted to inspect a picture book. The experimenter then proceeded with the test. A given note was sung by the experimenter and sounded on the xylophone or on a pitch-pipe. Two chromatic pitch-pipes, one in the key of F, the other in the key of C, were used. The children were asked to listen and to sing the same tone. Various means of encouragement, including the use of the xylophone and the picture book, were employed. The children soon learned what was expected of them, and as time went on less and less extraneous motivation was needed.

Each item of the test was presented separately, and the responses of each child to each item were separately recorded. After a given tone had been presented, the experimenter kept sounding and singing the tone to prompt the child's efforts. If the child succeeded in reproducing the tone no further response was required until the next item was presented. If he tried to sing the tone and failed to reproduce it correctly or if he remained silent the experimenter continued to sing and sound the tone a maximum of eight times. Fewer than eight presentations were made if the child's attention could not be held. If the child reproduced the presented item he was credited with a 'hit;' if he tried but failed he was credited with an 'at-

tempt;' if he continued to remain silent, his record on the particular item was entered as 'no attempt.' A record of the number of trials preceding success was also made. Each of the 11 notes of the pitch test was dealt with in this manner.

The pitch test was administered three times, on three different occasions, during the initial test series. When the record was scored, one credit was given to each note correctly reproduced. If the child sang a given note on only one test or on all three occasions when the test was administered he received one credit. The maximum score on the pitch test was, accordingly, 11.

The interval test was administered at two separate times after the completion of the pitch tests. The general procedure was the same as that described above, save that two notes constituting an interval were presented instead of separate notes as in the pitch tests. Each interval correctly reproduced during one or both administrations of the test was given one credit in the final score. The maximum score according to this procedure was 12.

Method of evaluating the child's responses

Of first importance in a study of this kind is the need for a valid means of evaluating and scoring the responses made during the tests. Much time was spent in preliminary experimentation to find a procedure which could be used expeditiously in work with children at this early age and still yield reliable quantitative results. The use of a mechanical device, such as a

tonoscope, for recording the children's responses was considered, but after preliminary work it was felt that the purpose of the study could be served without a device of this kind. The procedure of requiring the experimenter to judge the correctness of the child's response was tried and appeared to give satisfactory results. Accordingly, during the course of the tests, the experimenter not only produced the notes or intervals which the child was required to sing, but also judged whether the child's responses correctly reproduced the tones which were being presented. In forming a judgment the experimenter made use of the musical instruments as a basis of comparison between the child's responses and the tone that was required. No response was recorded as correct unless in the opinion of the experimenter it was definitely in accord with the tone which was being sounded on the musical instrument. A description of methods designed to ascertain the validity of the experimenter's judgments follows.

Reliability of the judgments of the child's responses

Various means were used in checking upon the reliability of the experimenter. First of all the experimenter was tested by another musician. The tester sang at random all the notes used on the initial tests given to the children, taking her note from a piano which was not within the hearing of the experimenter. She recorded each note thus sung. The experimenter in the meantime was required to identify (by aid of a pitch-pipe) and to record each note that was sung. After

the test had been completed the tester's and the experimenter's records were compared, item by item. The experimenter made a perfect score on each of three repetitions of the test.

A more significant check on the reliability of the experimenter was obtained by introducing other musically trained examiners while tests were being given the children during the course of the study. The persons thus brought in took independent records of the children's performances while they were being tested by the experimenter.

On one occasion, 20 children were tested in this way, both for pitch and interval, by the experimenter and a second examiner. After the completion of the tests, the separate records were compared.

The pitch test on which simultaneous and independent records were made by the two examiners included the 11 notes of the initial pitch test. The total possible score for the 20 children was, accordingly, 220. An item by item comparison of the two independent records showed an agreement of over 96 per cent. (The judgments were in disagreement on only 7 notes in the total of 220.) The experimenter credited the children with 125 correct hits, one of which had been judged incorrect by the second examiner, while the second examiner credited them with 130 correct hits, six of which had been judged incorrect by the experimenter.

On the interval test, each child was tested by both examiners on the 12 intervals of the initial tests. The total possible score for the 20 children was 240. An item by item comparison of the records showed an agreement of

95 per cent. The two examiners agreed in judging 152 items as correctly reproduced and 75 items as incorrectly reproduced. The experimenter judged one response as correct which was judged incorrect by the second examiner, while the second examiner gave credit to twelve responses which were judged incorrect by the experimenter.

It can be observed that there was not only a high percentage of agreement between the two examiners, but also that the experimenter was more rigid in giving credit than was the second examiner.

The same method of checking upon the reliability of the records was used at a later stage of the experiment when still another musician was introduced to take simultaneous and independent records during the pitch tests. This musician, like the person previously introduced, possessed what is known as "absolute pitch." On this occasion, 10 children were tested on 11 notes, making a possible total score of 110. Once more an item by item comparison of the records was made at the end of the tests. The agreement in this instance was 96 per cent. Two items which had been credited as correct by the experimenter were recorded as failures by the second examiner, while on the other hand, this second examiner had given credit for 2 items which the experimenter had recorded as incorrect.

The above results indicate that the method of testing used in this study showed a high degree of reliability within the limits of the procedure employed.

The reliability of the tests, as

measured by correlating the scores obtained by the experimenter on successive repetitions ranged from $+.54 \pm .11$ to $.95 \pm .02$, with a median of $.80 \pm .06$.

It can be seen that the testing procedure corresponded quite closely to the type of test situation which an individual must face under practical circumstances, in school or even in performance of a professional character. The method, while showing high reliability when employed by different examiners did not, to be sure, give a measure of the exact vibration frequency of the tone produced by the child. The measurements were, however, sufficiently precise to measure not only individual differences in general range of musical performance, but also to test a given child's ability to reproduce the various steps of the musical scale.

Extension of the tests

As the study progressed, it appeared that the children were improving to such a degree that it was necessary to extend the range of notes and intervals used in the training series and in periodic retests. The tests were therefore augmented to include the original 11 notes used in the pitch test, plus the following notes: G, A, B, below Middle C, and G, A, B, and C, two octaves above Middle C, making a total of 18 notes. The interval test was augmented by the following intervals: ascending and descending major and minor sixths and sevenths, and octaves, making a total of 22 intervals.

In order to provide an instrument to cover these additions, a psaltery was added to the pitch-pipes and xylophone which had been employed from

the beginning of the study. The psaltery was tuned daily.

Methods of training

Following the initial tests the experimental children were given further training in singing. Songs taken from music books for young children were used for this purpose. The children were brought to the music room, which adjoined the playground, two at a time. The experimenter would sing the songs and ask the children to join in the singing. As the study progressed special attention was given to difficult parts of the song.

The practice period was designed to last 10 minutes. Early in the study it was not found possible to maintain the interest of some of the children during the entire 10 minutes. Later in the study, when all the children were quite eager to partake in the music training, the period was sometimes extended to 15 minutes to compensate the earlier loss of training time.

At the beginning of the training series the children were permitted to play on the musical instruments, to improvise songs of their own or to try to sing the presented song more or less as they pleased. The experimenter again used various means to stimulate the child's interest in singing the songs that were used for training purposes; for example, when one of the songs, a lullaby, was presented, the child was encouraged to accompany the experimenter in going through the motions of putting a doll to sleep, while singing; another song, which ended with the words 'peek-a-boo,' likewise could readily be acted out to the accompaniment of singing. As time went on

the children responded more readily without such incidental promptings.

Eight songs were used for training purposes. Three of these were used at the beginning of the training while the others were introduced one at a time as the study progressed. During training the policy was used to group a child who showed relatively much ability with one who was less competent. Furthermore, the children were rotated in such a way that each child would sing with a different child on different days. Each child received an average of two training periods a week. When tests were given the test took the place of the training period. If a child missed training periods by reason of absence from school, extra periods were allotted to him on his return. In addition to the initial and final tests, given in the months of December and May, respectively, the pitch and interval tests were introduced in January, February, and March. Since these tests are in themselves a form of training, the periods devoted to them are counted as a part of the child's training series. Each child received forty training periods, including the periods devoted to the tests preceding the final test in May.

Spontaneous vocalizations

A study of the children's spontaneous vocalizations constituted a separate project within the investigation.

The children were observed during the course of their free play at the nursery school during the morning hours. Each child was observed for a total period of 100 minutes, divided into at least ten intervals occurring at different times over a period of three to five months.

The investigator followed the child as closely and unobtrusively as possible. Whenever the child sang, hummed, chanted, or made outcries which could be heard clearly and which could be located on the musical scale a record of his response was made. Pitch-pipes were used to identify each response that was recorded. So far as possible, the verbal content of the child's responses, the activities accompanying his response, and the rhythmic pattern of his vocalization, if any could be observed, were also recorded.

This procedure was calculated to provide a general indication of the character of children's spontaneous singing, and of individual differences in the content of children's musical expressions during the course of their undirected activities. The results cannot be regarded as final measures of the absolute frequency of the children's singing, since notes sung in an undertone, or notes which could not be identified by reason of lack of clearness or distraction or other factors, were not entered upon the records.

RESULTS

In the presentation of the results, the topics covered in the study will be treated in the following order: findings on the initial pitch and interval tests; the influence of practice on the child's performance; the extent and content of children's spontaneous vocalizations; correlation between various measurements.

The initial pitch tests were given to 48 children, and the initial interval tests to 47, including the 18 children subsequently used for training. The age range was 31 to 48 months, aver-

age 39 months. The average number of notes sung by 48 children on the three trials of the pitch test, containing the 11 notes from Middle C to F above C an octave higher was 4.20 ± 2.44 . The average number of intervals sung by 47 children on the two trials of the interval test containing the 12 intervals (ascending and descending major and minor seconds and thirds, perfect fourths and fifths) was

TABLE 1

Number of children correctly reproducing the various notes and intervals on the initial tests, based on 3 repetitions of the pitch test, and 2 repetitions of the interval test, with allowance of only one credit for each note or interval sung during the test series

Pitch (48 cases)											
MIDDLE C	D	E	F	G	A	B	C	D	E	F	
19	28	30	27	29	22	13	12	11	6	5	

Interval (47 cases)											
ASCENDING						DESCENDING					
Major second	Minor second	Major third	Minor third	Perfect fourth	Perfect fifth	Major second	Minor second	Major third	Minor third	Perfect fourth	Perfect fifth
24	18	17	13	12	13	26	11	22	23	16	8

4.32 ± 2.90 . The scores for the experimental and control children used in the training study are given in a later table.

The results of the initial tests were examined to study the range of the children's voices, and to find where their voices were placed. Table 1 shows the number of children who were able to sing each of the notes and intervals covered in the tests.

It appears in table 1 that the notes from D to A inclusive were reproduced most readily by the children used in this study. It further appears that the closer intervals, such as the seconds and thirds, were reproduced more readily than the wider intervals. The descending intervals have a slight but not significant advantage over the corresponding ascending intervals.

The findings with regard to pitch differ somewhat from usual statements with regard to the voices of young children. The claim is usually made that songs for young children should fall within the compass extending from E first line to E fourth space. (See references 2, 3, 5.) The authors have been unable to find published experimental data to support this claim. Even less definite are many writings on methods of teaching singing to young children which state that songs should be within the compass of the child's voice, without giving definite indications of what this compass is.

The findings in the present study indicate that the voices of young children are placed lower than is commonly supposed. It appears that when actual tests were given the notes Middle C, and D above Middle C, (both of which are below the first line E), were sung considerably more readily than C and D an octave higher, and that very few children sang the E and F (an octave above Middle C) which have been regarded as well within the range of the child's voice.

It is true that the statements with regard to the range of children's voices usually pertain to children somewhat older than those used in this study. It is possible that the voices of children

at the age of six favor a higher range than the voices of three year old children. But it may be said at this point, in anticipation of findings which will be presented later in greater detail, that it was found that following intensive training the children of this study scored higher on the notes below first line E than on the higher notes immediately beyond the fifth line F which has been regarded as well within the range of the voices of young children. On the final pitch tests given to the 18 children who received training the number of children who sang each of the 18 notes of the extended test was as follows:

(Middle 1st line)

G	A	B	C	D	E	F	G	A
5	15	17	18	18	18	18	18	18

5th line

B	C	D	E	F	G	A	B	C
18	17	18	17	15	15	14	13	9

In later tests of songs used for training purposes, the low notes (Middle C, D, Eb) again scored substantially higher than the high notes (D, E, F beyond C an octave above Middle C). It thus appears from the initial pitch tests, from final pitch tests given after training, and from the tests employing actual songs used in training, that three year old children, as represented in this investigation, can sing notes below the commonly accepted range quite as readily as some of the higher notes which have been regarded as well within the child's capacity.

This finding that children's voices are placed lower than is commonly supposed was unanticipated in the present study. At the beginning of the investigation, the experimenters planned their approach in accordance

with the supposition that children's voices favored the higher notes. Early in the training period, however, it became evident that this procedure had to be revised. It was often found that by transposing the songs used for instruction a more ready response could be obtained. Children who had previously remained silent made efforts to sing after the songs had been transposed to a lower key. Only in the case of the spontaneous vocalizations, as will be indicated at a later point, did the children tend to favor a higher range of notes.

The results from the initial interval tests indicated that the closer intervals (i.e., the seconds and thirds) were reproduced more readily than the wider intervals (fourths and fifths). In the literature opinion is divided as to the relative ease with which children can sing narrow and wide intervals. The opinion is sometimes set forth, however, that the half-step or chromatic interval (minor second) should not be stressed in songs for the young child. Thorn (5) warns against the use of difficult half-steps; the New York Board of Education Music Syllabus (3) and Damrosch, Gartlan, and Gehrkins (1) do not formally introduce instruction in the use of chromatics in songs until the fifth year of school.

In table 1 it appears that the minor second was sung less frequently than the major second and the minor and major thirds, and slightly more frequently than the perfect fourths and fifths. The score for the minor second interval is relatively quite high, and does not tend to support the view that the chromatic interval should not be

used in songs for young children. As will be shown in a later table dealing with the children's spontaneous vocalizations, the chromatic interval occurred more frequently than any other interval with the exception of the major second. On the final tests the minor second was sung by all of the 18 children who had received training.

The influence of training

Table 2 shows a comparison between the experimental and the control groups of children used in the study of the effects of training. The ages for all children are calculated to January 1, 1931. The initial tests of the experimental children were completed in December 1930, while the controls were not completed until early in 1931. This discrepancy constitutes a defect in the experimental procedure which could not be overcome entirely. To compensate, in part, for this early discrepancy, the final tests of the controls were administered after final tests had been given to the experimental children. It can be seen further that there is a difference of over a month in the average ages of the two groups. Many of the children who had been given the initial tests and paired with children in the experimental groups were not obtainable for the final tests, due to contagious diseases. The use of other children who had been given the first tests and who were still available for the final tests increased the average age of the controls as indicated on the table. In the case of the interval tests, only sixteen controls were available for comparative purposes at the end of the study.

In spite of these shortcomings, a

comparison of the two groups of children before and after training offers instructive findings.

The table gives results not only on the initial pitch and interval tests (Designated Test A, containing 11 and 12 notes and intervals respectively) but also on the extended tests introduced later in the study. The control group was measured on the extended scale only on the final tests. The initial pitch test was repeated three times, the initial interval test twice; the final pitch and interval tests were given three times to the controls, and twice to the experimental children.

In scoring the tests, only one credit was given for each item; if the child sang a given note correctly only once during the series or sang it on each repetition of the test, he received one credit for his performance in either case. Accordingly, the maximum score which a child could receive on the initial and the final pitch test series was 11, and on the interval test series, 12. In the case of the extended tests, the maximum scores obtainable were 18 (pitch) and 22 (interval).

It appears in table 2 that the children who had received training scored considerably higher on the final tests than those who were tested only at the beginning and end of practice. The difference between the averages of the two groups on the final tests are reliable in all cases ($\frac{\text{Difference}}{\text{S. D. difference}}$ ranges from 3.59 to 6.84).

Tables 3 and 4 show the improvement in the average scores in pitch and interval during the course of training. Separate figures are given for the scores on the extended tests that were intro-

duced two and a half months after the beginning of the study, when it became evident that most of the children were approaching a maximum score on the tests used at the beginning of the study.

The range of the scores on the initial pitch test represented in table 3 was 0 to 11 (maximum score, 11) on first

22 respectively on first and final presentations.

Influence of training on variability. The results in tables 3 and 4 show a tendency toward a decline in relative variability as the training proceeds. Even in the case of the extended tests introduced late in the training period the relative variability is a good deal

TABLE 2

Comparison between average scores of experimental and control children on pitch and interval tests given at beginning and end of study of effects of training

	EXPERIMENTAL	CONTROL
Pitch (18 pairs)		
Average age in months.....	38.18 \pm 3.69	40.11 \pm 3.93
Average number notes correctly sung on first test (Test A, 11 notes).....	4.22 \pm 2.44	4.22 \pm 2.71
Average number notes correctly sung on repetition of (Test A) at end of training.....	10.72 \pm .11	6.44 \pm 2.89
Average notes correctly sung on extended test (Test B, 18 notes) at end of training.....	15.50 \pm 1.78	8.00 \pm 3.22
Interval (16 pairs)		
Average age in months.....	38.75 \pm 2.94	40.56 \pm 3.69
Average number of intervals correctly sung on initial test (Test A, 12 intervals).....	4.25 \pm 3.03	4.31 \pm 2.89
Average number of intervals correctly sung on repetition of Test A at end of training period.....	11.50 \pm .67	8.00 \pm 2.50
Average number of intervals correctly sung on extended test (Test B, 22 intervals) at end of training.....	17.0 \pm 4.25	10.18 \pm 4.26

presentation, and 8 to 11 on final presentation at the end of training. The range of the extended pitch test on first presentation was 2 to 16 (maximum 18), and on final presentation, 11 to 18. The scores on the interval test showed an initial range of 0 to 10 (maximum, 12), and on final presentation of the same test the range was 9 to 12. The extended interval test showed a range of 6 to 21, and 9 to

lower than on the initial more limited tests.

The fact that there was a maximum limit to the score which a child could obtain on the tests, and the further fact that the same amount and character of training was given to all the children no doubt contributed largely to the apparent decline in variability as shown in tables 3 and 4. If the tests and the training had been graded ac-

cording to individual differences exhibited early in the study it is possible that the improvement shown in the final results would be even higher than the gains set forth in tables 3 and 4, and that individual differences would have remained more constant through-

voice range of 14 fathers and 15 mothers of the children who were given training were tested, the fathers sang an average of 20 notes, the mothers an average of 19. The children's average score of 15.5 notes on the final test, as indicated in table 3, does not differ

TABLE 3

Average scores on pitch test when repeated at various stages of training given to 18 3-year old children. Separate averages given for test as extended late in training period (Test B)

TEST A 11 ASCENDING NOTES FROM MIDDLE C TO F		TEST B 18 NOTES FROM G (BELOW MIDDLE C) TO C (2 OCTAVES ABOVE MIDDLE C)	
Repetitions of test	Average number of notes correctly sung	Repetitions of test	Average number of notes correctly sung
December.....	4.22 \pm 2.44		
January.....	4.56 \pm 2.90		
February.....	6.50 \pm 3.33		
March.....	8.78 \pm 2.00	March.....	10.67 \pm 2.78
May.....	10.72 \pm .11	May.....	15.50 \pm 1.78

TABLE 4

Average scores on interval test repeated at various stages of training given to 18 3-year old children. Separate averages given for test as extended late in training period (Test B)

TEST A ASCENDING AND DESCENDING MAJOR AND MINOR SECONDS, MAJOR AND MINOR THIRDS, PERFECT FOURTHS AND FIFTHS (TOTAL: 12 INTERVALS)		TEST B ASCENDING AND DESCENDING MAJOR AND MINOR SIXTHS, MAJOR AND MINOR SEVENTHS, AND OCTAVE, PLUS INTERVALS OF TEST A (TOTAL: 22)	
Repetitions of test	Average number of intervals correctly sung	Repetitions of test	Average number of intervals correctly sung
December.....	3.94 \pm 3.05		
January.....	4.33 \pm 2.89		
February.....	8.05 \pm 2.61		
March.....	9.33 \pm 2.33	March.....	11.11 \pm 3.44
May.....	11.56 \pm 1.00	May.....	17.44 \pm 4.00

out the study. It is the marked improvement shown by the group as a whole in response to a training and test procedure constant for all children, rather than the findings with regard to changes in variability, that are of major interest in the results set forth in tables 3 and 4. (When the complete

widely from the average scores of the parents.)

Children's attitude toward prolonged training. A further word should be said with regard to the response of young children to training in singing over a long period of time. The quantitative findings above have already

indicated that the children reacted favorably to the procedure. During the course of the study evidences of the children's continued interest and willingness to cooperate appeared in many forms. At nearly all times the children willingly left their play to go to the room where the music was given. The children were never coerced. On rare occasions a child would temporize or refuse because of the attraction of the play in which he was engaged, but the following day he would often ask to be allowed to come to the music room. All of the children on many occasions asked for permission to come next, while many of them made daily requests for a turn at music. Sometimes a child would object to leaving the playground at the usual time prior to luncheon if he had not spent a period at music. On the whole, after the study was in progress, more persuasion was used in getting the child to leave the music room than in requesting him to come. The children tested for control purposes, although seen less frequently, showed an eager interest after brief acquaintanceship with the procedure.

Before the study was begun, the question as to whether the interest and cooperation of children could be maintained seemed almost as significant as the question regarding the possibility of improving children's performance in singing. The responsiveness shown both by the experimental and the control children used in this study, quite apart from any consideration of the objective findings, convince the investigators that much practical work in music can be done at this early age with encouraging results.

Tests covering songs used in training.

Prior to the final pitch and interval tests, the children were tested on their ability to sing the songs which had been taught during training. The tests, covering the entire list of songs, were given twice on different days. Each child was tested individually. During the tests, the experimenter kept a record of the notes that were sung and of the child's reproduction of the rhythm of the songs. A stenographer kept a record of all the words spoken and sung by the experimenter and the children. At the conclusion of the tests, the records yielded a score for each child on reproduction of pitch, rhythm and words.

When the song tests were given, the child was first given opportunity to sing the songs to the accompaniment of an instrument but without verbal prompting. If he failed to proceed without help, or sang incorrectly, the experimenter prompted a second attempt. The stenographer made a record, in proper sequence, of all that was said. In scoring the child's performance two credits were given for each note reproduced without prompting, and one credit was given for a correct response following prompting. One credit was given for each word and rhythmic phrase correctly reproduced. In scoring the song which contained serial repetitions of a single word, credit was given to each group of identical words rather than to each separate word.

When the child's final score on these tests was computed, credit was given for each unit correctly reproduced, whether the item had been sung on both or only on one of the two presentations of the test. When the two

repetitions of the song tests were scored separately, the correlations between the first and second presentations were as follows: Words, $r = .83 \pm .05$; pitch, $r = .75 \pm .07$; rhythm, $r = .78 \pm .07$.

The scores obtained on the final song tests were as follows: Pitch, range = 21 to 194; average = 108 ± 41 (maximum possible score, 220). Words, range = 24-75; average = 55 ± 12 (maximum = 75). Rhythm, range = 5 to 14; average = 10.33 ± 2.62 (maximum 14). Earlier in the training period tests were made of the children's ability to reproduce the notes of the songs first introduced. The maximum score on these earlier tests was 10. The average score obtained was 4.67 ± 2.96 . The correlation between scores of pitch reproduction on these early tests and the final tests described above was $.93 \pm .03$.

At the end of the study all of the children could sing some of the songs and parts of others, while some of them could sing all the songs with little prompting. In a later section correlations between the scores on the above tests and other measures are given.

Examination of the results of the final song tests revealed that the low notes of the songs were reproduced more readily than the high notes. It appeared that the notes Middle C, D and Eb (which are supposed to fall below the child's favored range) scored respectively 68, 80 and 67 per cent., while the higher notes D (above C an octave higher than Middle C), E and F (which have been regarded as well within the child's range) scored respectively only 50, 33, and 25 per cent.

Spontaneous vocalizations

Records of the children's vocalizations while at play, obtained during a total of 100 minutes of observation of each child, with the procedure of recording only those notes which could definitely be verified by means of pitch-pipes when the child sang, hummed, chanted, etc., provided a variety of findings.

The data were first examined to find the number of notes, intervals, and rhythmic measures recorded for each child. The notes sung by the child were scored by allowing one credit for each separate note recorded.

The records also provided a measure of the range of notes covered by each child in his spontaneous singing. This score represents the total number of different notes that were recorded for each child rather than the number of times each note was sung. A similar score was obtained for the number of different intervals which occurred in the child's vocalizations.

The data were further examined to find the number of times series of three notes or more which could definitely be placed within either the diatonic or chromatic scale occurred in the record of each child. Each record was also scored on the number of complete rhythmic measures which the observer had been able to identify clearly while the observations were being made.

Table 5 shows the averages and the average deviations of the various scores derived from the records of the spontaneous vocalizations of the eighteen children. Averages are given first for all vocalizations, including singing, calls, outcries, etc., while the second

caption covers only the notes definitely sung, hummed or chanted. Averages are given for the total number of series of notes sung within a scale and separate averages are shown for the number of such series that could definitely be placed in the diatonic and chromatic

ments represented in the table are correlated with the results of tests and other measures.

The figures showing the frequency of the diatonic and chromatic scales are small, but they are of interest in showing that children at this age do

TABLE 5

Averages of the total number of notes and intervals, of the number of different notes and different intervals, rhythmic measures, and number of series of notes sung within a scale, occurring in records obtained during 100 minutes of observation of the spontaneous vocalizations of 18 children

	NUMBER OF NOTES IN ALL VOCALIZATIONS	NUMBER OF NOTES SUNG, HUMMED, CHANTED	NUMBER OF DIFFERENT NOTES	TOTAL NUMBER OF INTERVALS	NUMBER OF DIFFERENT INTERVALS	RHYTHMIC MEASURES	SCORES OF NOTES WITHIN A SCALE	DIATONIC SCALE	CHROMATIC SCALE
Range.....	16-213	7-207	5-15	2-45	1-8	0-11	0-10	0-6	0-3
Average.....	63	52	11.4	12	3.9	3.9	3	1.61	1.06
A. D.....	35	37	2.2	8.8	2.3	3.5	2.67	1.48	1.11

TABLE 6

Number of times each note occurred in the spontaneous singing, humming, chanting and outcries of 18 children during 100 minutes of observation devoted to each child

	MIDDLE C	C#	D	D#	E	F	F#	G	G#	A	A#	B	C	C#	D	D#	E	F	ABOVE F
Singing.....	0	3	5	4	10	63	30	53	61	172	81	62	84	28	72	3	12	0	3
Chanting and humming.....	0	0	2	0	8	6	5	6	17	16	15	20	40	8	25	10	6	9	0
Outcries (including talking, calls, etc.).	0	0	4	4	0	2	5	10	12	38	21	29	24	6	22	8	8	6	2
Total vocalizations.	0	3	11	8	18	71	40	69	90	226	117	111	148	42	119	21	26	15	5

scales. Series which might be regarded as either diatonic or chromatic were not included in the latter averages.

The results presented in Table 5 show wide individual differences. In a later section, the various measure-

not limit their singing entirely to isolated notes.

Table 6 shows the frequency with which each of the various notes occurred in the spontaneous singing, humming, and chanting and in the children's calls, outcries, etc. Sepa-

rate figures are given for frequencies in each category, as well as for all vocalizations combined.

The results shown in table 6 indicate that the spontaneous vocalizations tended to favor a relatively high range of notes. The notes from F above Middle C to D occurred most frequently. It is interesting to note that the children favored lower notes during the tests, as shown in previous sections, and somewhat higher notes when singing during their free play. It appears in table 6 that the higher notes occur relatively more frequently

It further appears in table 7 that the ascending and descending minor second or chromatic interval occurred more frequently than any other interval save the major second.

Reference to table 5 will show that series of three or more notes within the chromatic scale occurred almost as frequently as series within the diatonic scale. The results of the initial and final tests likewise showed a substantial score for the chromatic interval. It appears from all phases of the present study that chromatic intervals are not beyond the singing ability of the three-year old child.

TABLE 7

Frequency of occurrence of each interval recorded during observations of the children's spontaneous vocalizations

ASCENDING						DESCENDING					
Major second	Minor second	Major third	Minor third	Perfect fourth	Perfect fifth	Major second	Minor second	Major third	Minor third	Perfect fourth	Perfect fifth
20	24	4	9	2	0	53	46	8	50	3	0

in the children's calls, outcries, etc., than in their actual singing.

Table 7 shows the number of times each interval occurred in the records of spontaneous vocalizations.

The results presented in table 7 indicate that the descending intervals occurred more frequently than the ascending intervals in the children's spontaneous vocalizations. The closer intervals (seconds and thirds) scored considerably higher than the wider intervals (perfect fourths and fifths). This is in accord with the results obtained on the tests administered during the study.

Intercorrelations in the musical behavior of young children

Table 8 shows the coefficients of correlation between various measures and scores obtained for the 18 children who were given training. All coefficients were obtained by the rank-difference method. The P.E.'s which are not entered, range from $\pm .16$ with a coefficient of zero, to $\pm .02$ with a coefficient of .95. To derive the measures represented by the caption "scores on pitch test (and interval test) after training," the children were ranked according to priority in obtaining a perfect score on the pitch and interval tests during the training series.

Most of the coefficients appearing in table 8 are positive. Intelligence quotient shows the lowest median coefficient, while the highest median coefficients are shown for total number of notes sung in spontaneous singing, and scores on rhythm and melody in the final song tests.

Correlation between spontaneous singing, humming and chanting frequencies

and frequency of laughter and overt activity. From other studies made with children's laughter and general overt activity. The correlation between the

TABLE 8

Intercorrelations between various measurements obtained in the study of 18 trained children

	PITCH TEST BEFORE TRAINING	INTERVAL TEST BEFORE TRAINING	SCORE ON FIRST TEST OF SONGS	PITCH TEST AFTER TRAINING	INTERVAL TEST AFTER TRAINING	FINAL SONG TEST: MELODY	FINAL SONG TEST: RHYTHM	FINAL SONG TEST: WORDS	SPONTANEOUS SINGING: TOTAL NOTES SUNG	SPONTANEOUS SINGING: NUMBER OF DIFFERENT NOTES SUNG	SPONTANEOUS SINGING: TOTAL INTERVALS	SPONTANEOUS SINGING: NUMBER OF DIFFERENT INTERVALS	SPONTANEOUS SINGING: TOTAL CHROMATICS	SPONTANEOUS SINGING: TOTAL RHYTHMIC MEASURES	INTELLIGENCE QUOTIENT
Score on pitch test before training															
Score on interval test before training . . . . .	.70														
Score on first test of songs . . . . .	.52	.70													
Score on pitch test after training . . . . .	.56	.57	.79												
Score on interval test after training . . . . .	.47	.53	.68	.49											
Final song test: melody . . . . .	.51	.58	.93	.76	.80										
Final song test: rhythm . . . . .	.39	.53	.92	.76	.57	.91									
Final song test: words . . . . .	.49	.75	.81	.69	.70	.80	.73								
Spontaneous singing: total notes sung . . . . .	.09	.29	.52	.46	.48	.59	.63	.47							
Spontaneous singing: number of different notes sung . . . . .	.19	.00	.18	.38	.29	.29	.35	.22	.81						
Spontaneous singing: total intervals	-.05	.18	.39	.27	.41	.51	.55	.33	.93	.72					
Spontaneous singing: number of different intervals	-.04	.18	.48	.26	.26	.50	.60	.37	.84	.61	.93				
Spontaneous singing: total chromatics . . . . .	.09	.12	.41	.34	.37	.45	.54	.32	.77	.63	.85	.85			
Spontaneous singing: total rhythmic measures	-.03	.39	.40	.23	.21	.29	.41	.32	.72	.50	.67	.62	.53		
Intelligence quotient . . . . .	.35	.42	.39	.46	.28	.25	.29	.31	.32	.25	.32	.35	-.07	.19	
Median . . . . .	.37	.475	.52	.475	.475	.545	.56	.48	.555	.32	.46	.49	.43	.395	.315

the same children, ratings were obtained on the frequency of the children's laughter frequencies and their scores on total number of notes

sung, hummed or chanted during observations of spontaneous vocalizations was $-.23$; between the latter measure and overt activity scores, the correlation was $+.01$. It would appear from these figures that there was no significant relationship between the children's tendency to sing, insofar as this tendency was measured in this study, and their tendency to laugh or to engage in physical activity.

Correlations between parents and children. As a further project, the voices of the children's parents were tested. To obtain a rating for the lower and upper ranges of the parents' voices, a numerical score was assigned to each note of the range covered by all the subjects. The highest and the lowest notes were given, respectively high and low numerical values. In rating the performance on the low notes, the highest rank was given to the lowest value. The correlations between the parents and children follow. Fifteen mothers, fourteen fathers, and thirteen cases of both parents combined, are represented in the correlations.

Child's score on first pitch test and voice range of mother = $-.24$; father $+.21$; both $-.09$

Child's score on final pitch test and voice range of mother = $+.12$; father $+.20$; both $+.29$

Child's ability to sing low notes on final test and lower range of voice of mother = $+.17$; father $+.59$; both $+.62$

Child's ability to sing high notes on final test and higher range of voice of mother = $+.29$; father $+.17$; both $+.31$

The coefficients above indicate that the child's final performance correlated higher with parents' range than did the child's first pitch score, and that children tend to resemble their parents

more in the place of their voices (whether high or low) than in the range of their voices. The reliability of the coefficients is too low, however, to support any conclusions.

Sex differences

The data were examined for evidences of sex differences. In the pitch tests, the boys scored consistently higher than the girls in number of notes sung and also in ability to sing both high and low notes. Since the number of cases was limited, this difference in favor of the boys may be due merely to chance.

MISCELLANEOUS OBSERVATIONS AND DISCUSSION OF RESULTS

During the course of the study, certain general impressions were obtained, apart from the objective data. Some of these may be stated briefly.

It was frequently observed, in the case of children whose voices were placed low, that to concentrate the training on notes considerably higher than the child's favored range, and then to proceed downward toward this range, was more effective than to concentrate first upon notes immediately above the favored range.

It would appear that the general muscular adaptation involved in singing high notes differs somewhat from the motor pattern involved in the singing of low notes. The progression from low to high notes does not seem to constitute solely a continuous function but appears to entail also a shift in emphasis from one muscle group to another. In the present study it was often found that a child would be able during a period of time to sing

some high notes and some low notes without being able to reproduce the notes in between. In a case such as this, it appeared that the child had 'found his voice' for high tones without, as yet, being able to make the transition between the muscle groups respectively involved in the singing of high and low tones.

This statement is offered only as a hypothesis. The authors do not have the empirical data necessary for a thorough treatment of the problem. It is possible that the phenomenon mentioned above may have some relationship with auditory tonal gaps.

Among factors responsible for poor performance in response to musical training, the authors would list the following: Inability to make the transition between high and low notes, as suggested above; presentation of songs pitched too high or too low for the particular child; the tendency of some children to sing too loudly; the failure of some children to give undivided attention to the particular items that are presented.

In the spontaneous singing, snatches of songs taught at home or at school occurred far less frequently than the children's own improvisations. The child's song sometimes related to his current activity or play, and sometimes contained only repetitions of syllables or words. These songs rarely exceeded three measures, but frequent repetitions of the same tune, sometimes with slight variations, were relatively common. The observer obtained the impression that the children sang somewhat more when alone than when in the company of several other children. The activities involving

rhythmic motion, such as swinging and teetering, tended to be accompanied by singing more than other types of activity.

There was no evidence that the children strained their voices in singing the extended range of notes introduced into the training period. The practice of encouraging the children to sing softly no doubt helped to insure against strain.

The procedure of pairing a relatively good singer with a less capable child during the training periods seemed to be an effective device. Rivalry was not encouraged, nor did evidences of rivalry appear, but the presence of a child who would sing seemed to promote the efforts of other children.

SUMMARY AND CONCLUSIONS

The present study was undertaken to investigate the ability of three year old children to reproduce pitch and interval, to study the effects of training on this ability, to investigate the content of children's spontaneous singing, and to find relationships between various phases of the child's singing behavior.

Initial tests were given to 48 children. Training was administered to 18 children over a period of 6 months. Each child received 40 ten-minute periods. Tests were given at intervals during the course of training. At the end of the study the trained children were tested and compared with children of a control group who had received no formal training since the administration of the initial tests. As a further project, each child who received practice was observed for a period of 100 minutes during his free

play, and records were made of his spontaneous vocalizations.

The results show that on the initial tests the ascending notes from middle C to A were sung most readily by the children. This result indicates that children's voices are placed somewhat lower than has commonly been stated in previous writings. In subsequent song tests, and final pitch tests the same tendency to favor lower notes appeared.

The results further indicate that the narrow intervals (seconds and thirds) are sung more readily than the wider intervals (perfect fourths and fifths): that descending intervals tend to be sung more readily than ascending intervals; that the half-step or chromatic interval was sung quite readily in the test situation, and occurred frequently in the children's spontaneous vocalizations. This latter finding does not support the view that the chromatic interval should be excluded from songs for young children.

Training caused a marked improvement in the performance of the children. While the training was in progress it was found necessary to extend the range of notes and intervals covered in the study. On the three repetitions of the initial tests, 11 notes, extending from middle C to F above C an octave higher, were employed. The average number of notes initially sung by the 18 subjects used for training was 4.22 ± 2.44 ; at the end of training the average score on this test was 10.72 ± 1.1 .

The augmented test included the 11 notes of the initial test with four additional higher notes and three addi-

tional lower notes, extending from G below middle C to C two octaves above middle C. The score on this extended test, when first introduced after two and a half months of training was 10.67 ± 2.76 ; the final score on this test was 15.50 ± 1.78 .

On the interval tests the results showed a similarly high improvement with training. In the two repetitions of the initial test, which included twelve intervals (ascending and descending major and minor seconds and thirds, perfect fourths and fifths) the children sang an average of 3.94 ± 3.05 intervals, as compared with a final average score of 11.56 ± 1.00 after training. An extended test, containing a total of 22 intervals, (including, in addition to the above, the ascending and descending major and minor sixths and sevenths, and octaves) was introduced after two and a half months of training. The average score on this test, when first introduced was 11.11 ± 3.44 ; on the final test after further training, the average score was 17.44 ± 4.00 .

The scores of the practiced children were reliably higher than the final scores of the control group.

The records of the children's spontaneous vocalizations showed wide individual differences. The chromatic interval occurred relatively quite frequently. The children tended to favor higher notes in their spontaneous vocalizations than in their performance in tests of songs and of pitch. Relative frequency of spontaneous singing, humming and chanting showed a negligible correlation with frequency of overt activity and of

laughter, (records of which were made available through the courtesy of another investigator).

It appeared that children's voices tend to resemble the general trend of the parent's voice (whether high or low) more than their total pitch range. The reliability of all correlations between parents and children was low.

Apart from objective indications of the children's coöperation, as shown by progressive improvement in the test scores, the children gave evidence of interest in the musical exercises.

The results of the study as a whole indicate not only that children's performance in reproducing pitch and in-

terval can be much improved through training, but also that children at this early age are more versatile in the use of their voices than has customarily been stated.

It is not claimed that the marked improvement shown by the children represents a change in capacity or an alteration of native ability. The present study does not answer the question as to whether the child who receives training in singing at an early age will have a permanent advantage over the child whose voice is not trained until later. The findings do suggest, however, that training at the age of three can be undertaken with promising results.

REFERENCES

- (1) DAMROSCH, WALTER; GARTLAN, G. H.; AND GEHRKENS, G. H.: *Teacher's Book of the Universal School Music Series*. New York, 1923.
- (2) GIDDINGS, T. P.: *Grade school music teaching*. New York.
- (3) *Course of study and syllabus in music for elementary schools*. Board of Education, New York City, 1931.
- (4) SEASHORE, C. F.: The present status of research in the psychology of music. *University of Iowa Studies*, 2, 1928, 1-29.
- (5) THORN, A. G.: *Music for young children*. New York, 1929.
- (6) *Twenty-eighth year book of the national society for the study of education*. 1929, 720-722.

Treatment and Progress of an Extreme Case of Functional Anorexia

HELEN STREIT

"I HAVE seen children whom I am sure would have died from starvation if they had not been fed by insistent perseverance," says Dr. I. A. Abt (1). Such a child was X, according to the statement of her father, who was himself a pediatrician.

X was 2 years and 8 months old when we first met her. She not only lived in spite of herself but, due to her mother's determination and persistence, was kept up to weight and in good physical condition. Her health record was excellent. She had never been sick and was not even susceptible to colds. Her aversion to food started when she was 2½ months old and was so intense at that time that it took the mother two hours to feed her one meal. The milk was given to her from a spoon, as that was the only way she could be made to take it. She was fed 6 times a day, and it was only the extraordinary patience of the mother that prevented the necessity of resorting to tube or rectal feeding.

As X grew older the diet was gradually increased but since she would take only liquid or semi-liquid food, it was necessary to rub all food stuffs through a sieve and then reduce them to the "right" consistency with milk. Because of her great resistance, it was considered that the most practical

way of getting her to take a well balanced diet was to mix all of the food together. Milk and cereal formed the basis of the mixture. To it was added egg, vegetables, fruit or meat according to the time of day. The food was well salted but never sugared as she had a particular aversion to sweets. Liver extract and acterol were given separately. In spite of the taste of the former, it was the one item, with the exception of salt, that was taken willingly and even requested.

X was fed from a spoon, sitting on her mother's lap in a half reclining position. She ate in the kitchen. A large rubber apron was tied around her and the food was carefully dropped on the right side of her mouth, in the cheek cavity and not on the tongue. Any change in this procedure caused added resistance and increased the tendency to gag and vomit. In spite of the attention given to these details, gagging, belching, and coughing accompanied each meal and not infrequently the regurgitation of food occurred. On these occasions the rubber apron was removed, a new one substituted, and a second meal begun. The procedure was carried out very calmly in a matter of fact manner and was never varied. If necessary a third meal was given. The mother did

most of the feeding but sometimes X was left in charge of an aunt or the maid.

Many devices were used to make the situation as pleasant as possible. Simple games, by way of distraction, were played. An older brother or the maid entertained X in various ways; or if she complained of being too hot, fanned her. The frequent belching was relieved by rubbing her stomach and patting her on the back. When these methods failed, more drastic ones were used. The mother would threaten to leave her to be fed by the maid, perhaps, or deprive her of accompanying her father on his morning calls, if the trouble happened at breakfast time. When the child offered more resistance and threatened to vomit, one or two sharp slaps were administered and the vomiting was actually controlled to a certain extent in this manner. The child might cry slightly because of the spanking, but it was never the occasion for a big scene. Kisses and caresses were bestowed upon her when she was in a non-resisting mood by both father—when he was present—and mother. By the time she was 2 years and 8 months old the number of feedings had been reduced to 4 a day and the average feeding time was around twenty minutes.

Attempts had been made by the parents to establish more normal feeding habits. The good example set by them and by her brother was ineffective except that it gave her a good conversational attitude towards food in general. She would talk about the good food others were eating; she would sit at the table and watch them

eat, or go to parties where the children were served the most delectable sweets and never be tempted to put any of them in her mouth. She could be neither forced nor bribed into tasting them. Leaving food lying around in convenient places for her to take as she would offered no solution to the problem, for she never put anything into her mouth. Even as a baby she was unusual in that respect, the parents insist. She did not even compensate by sucking her thumb or fingers. At one time starvation was resorted to. Since X showed no sign of coming to terms during the 2 days when no food was proffered, this method was discontinued and the old regime reinstated.

In spite of the struggle over meals X was a bright, attractive, cooperative child with very pleasant and agreeable ways. She was not given any of the standard mental tests, but observation of her general behavior indicated that she was well above the average mentally.

She had been thoroughly examined and no trace of a physical difficulty could be found. X-rays had shown that the stomach was of normal size. Though somewhat slow in emptying the motility of the stomach was still normal. No attempt had been made to discover if there was a deficiency in the secretion of gastric juices but it was the father's opinion that that was not a factor. As her vomiting was not accompanied by fever and as the enlarged abdomen and lordosis which are external signs of ptosis and angulation of the intestinal tube were not present, it was believed those conditions were not complicating fac-

tors. Her general condition and lack of constipation argued against gastrointestinal atony. She was, furthermore, not an over active, high strung, underweight, underheight child; and although she was pale, her muscles were not soft and flabby. At 2 years 11½ months her height was 36½ inches and her weight 28½ pounds (nude) making her 1½ pounds underweight for her age and height and giving her an average height for her age according to the Woodbury tables. Her adenoids and tonsils were not enlarged or diseased. Her daily routine was particularly well planned; her diet was well balanced; and she had plenty of outdoor play, plenty of sleep, and was not over stimulated.

The possibility of a very slight throat paralysis was considered but certain facts seemed to indicate that the throat muscles were functioning normally. In the first place she had nursed normally for 2½ months. In the second place she could eat sitting up if she wished to do so, and she did drink water standing up, taking several consecutive swallows without pausing between. In the third place she showed no lack of skill in pronouncing throat sounds, such as hard "g" and "k." Furthermore she had swallowed solids on rare occasions. One time it was a piece of ice; another time, a lemon drop; and still another time, it was 6 beans, which she swallowed one right after the other. Although she never repeated these actions, the fact that she had swallowed solids without difficulty seemed proof that the throat muscles were at least fairly normal.

As the vomiting could be controlled so readily by spanking it did not seem

that it could be a symptom of some internal disturbance. The belching could be accounted for by the amount of air swallowed and this in turn because of the manner in which the child was fed. The gagging was probably the result of inadequacies in her swallowing techniques. Lack of taste discrimination and perhaps defective olfaction were considered as possible complications but the development, under our care, of discriminatory reactions with respect to foods make any sensory lacks seem improbable.

A study of the environment offers more convincing cues with respect to possible contributing causes. X nursed normally the first 2½ months of her life. Then because of illness of the mother she was taken off the breast and changed to bottle feeding. The transition was not abrupt, as she had been getting 2 ounces of skimmed cow's milk since the first few days of her life, the mother's milk being too rich. She was not, therefore, being changed to a new type of feeding without some preliminary experience with it. She objected, however, to taking more than 2 ounces from the bottle. Insistence on the part of the mother seemingly caused X to take less at each successive feeding until she refused to take any. Her refusal persisted and the condition became alarming in the eyes of the parents. She appeared to have gone on a hunger strike that was to last indefinitely. A way was found to make her take nourishment without resorting to tube or rectal feeding, i.e. milk was forced into her mouth with a spoon.

Although the parents report that she was not sick at this time it is

possible that she contracted a slight infection from her mother who took care of her in spite of the latter's illness. The mother had been under a very severe strain all during her pregnancy because of the sickness of her 9 year old son. He suddenly began having convulsions, with paralysis as an accompanying symptom. Although he was taken to several of the larger clinics on the Atlantic coast, the nature of his illness was never determined. It was diagnosed as infantile paralysis, spinal meningitis and encephalitis by some doctors while others frankly admitted they could not classify it. None of them could suggest treatment for the case and none offered any hope for his recovery. Except for the time when he was visiting the clinics with the father, he was under the complete care of his mother who could do little other than watch him grow worse from day to day. Thirteen days before X was born his condition was so serious that his death seemed only a question of hours. He was completely paralyzed except in one hand which he could move only slightly. His worst convulsions came that day. It was the crisis of his illness. He began then to improve slowly and within a year had recovered completely. The exact nature of the illness was never determined. There is no history of convulsions in either family.

To the strain and anxiety then of caring for this very sick son was added for the mother the illness and death of her father. The latter occurred a few weeks after X was born.

X was a full term baby. Her birth was normal. Her birth weight was 7

pounds. A picture taken when she was only 13 days old shows that she was a particularly wide awake and alert infant.

The mother seems to have suffered from no physical ills following the child's birth. Then she contracted what was called influenza. Although she had a fever of 100 for over a month she did not go to bed during that time. Since she nursed the baby for a week after the fever began it is possible that X was also infected and had the edge removed from her hunger. But we can only speculate on this part of the case.

It is significant that at the onset of X's feeding difficulties the mother was ill and apprehensive. It is probable that she became alarmed when the child resisted foods—a reaction due perhaps to a change in feeding methods—and insisted and forced before she had given the child adequate time in which to make her new adjustment. The mother's apprehension may have been intensified by her access to medical literature where she found reference to children whose loss of appetite and lack of hunger became so serious that they were saved only by tube or rectal feeding.

At any rate once the child's resistance to food was started there were a number of probable factors that entered in to complicate the case and favor the continuance of the habit. The mother seemingly is very jealous of the child's affections. Remarks indicate that she liked her important rôle as the only one who could be depended upon to make X eat consistently. She appears to have enjoyed being a slave to the child and

hated to see her grow up. Then, too, she seems to have had some concern for her young husband's reputation—it would never do for a pediatrician to have an underweight child. Because she felt that X must be kept up to weight above all things, she apparently could not bear to see her lose the weight which a starvation regime would have temporarily provoked. The attempted cures failed probably for that reason and also because she was convinced in advance that they would fail.

As for X there was no chance for her to develop a healthy appetite and pleasant experience with food as long as she was fed an ill-tasting and monotonous diet in a manner that justified her vomiting and belching, thus giving the scene even more unpleasant associations. That there would be trouble, furthermore, was suggested by the rubber apron and the special time and place of feeding her. Besides, the child now had a reputation to live up to. She doubtless knew she was different from other people and probably felt she had to remain different for the prestige it gave her. Lastly, contact with the solid foods had been so long delayed she must have felt painfully inadequate in the manipulation of them at three years. At any rate it was clear she did not know how to swallow them.

Believing, then, X's difficulties were largely functional, we took her as our problem and proceeded on that hypothesis. She was separated completely from her family and was put in a new situation with new people who had new attitudes. As these people were unfamiliar with her past life, they

would not serve as a constant reminder of her former behavior.

The transition to her new mode of life was made somewhat easier for her by a visit to the home by the author who was to have her in charge. The home situation was studied, as were also the methods used and routines followed; and X's acquaintance was made. A picture book of the Nursery School where X was to spend most of her time with 20 other children ranging in age from two to five years, was shown to her and left for her to look at before she came. She was told she was coming to the school and knew she would see and be with the author. She was not told, however, that she would be separated from her mother as we wanted the separation to be casual and undemonstrative. X left her mother right after she had breakfasted with the latter in the old way. The separation was very casual, the mother slipping away in her car while the child went in to see the Nursery School. Some of the child's most intimate possessions were brought into her new environment. Her own mattress, pillow and bed clothing, as well as a particular book with which she slept insured greater peace of mind to her than would have a totally strange bed. Some of her old toys were also transported to her new home and, of course, a trunk of clothes.

X's adjustment to the new situation and people was very rapid. There was no great emotional disturbance over the change and while she cried for her mother at nap time the first day, and again the next day, on the whole she took the transplantation very

calmly and naturally. She referred to her mother a number of times the first week, but with the exception of the first few times, without crying. Then subject of mother and home was dropped until the fifth week, when she began referring to home in a casual way. One time she was scribbling with a pencil and announced she was writing to her mother. Another time she saw a horse go down the street and she invited the author to "come see my pony at home." At this time she began comparing the author's ways with her mother's ways of doing things, telling the former she was not making the bed correctly or helping her to dress in the same way her mother did.

Although we expected to adapt our methods of procedure to the child's response, there were a few principles we set up at the beginning. She was to be given the same food as the other children, a sitting position was to be assumed and she was to feed herself. She was also to eat at regular times and was not to play with the food. Her interest was stimulated by having her set the tables, help in the kitchen, and serve the other children as well as herself. Doing this work was treated as a privilege and not a task. She was encouraged to be independent in other situations and was taught how to bathe herself, comb her hair, dress herself, etc. We depended upon the new environment to dim the old associations and above all we depended upon the examples of the other children to influence the child's mode of response in the new situation.

She conformed very well to our plans and showed herself amenable

to the right sort of suggestion. She always came into the dining room and sat down at the table willingly, very often leading the procession. The first morning when tomato juice was served was the only exception. She watched the children from near by and when asked if she would like to sit down with them said, "No." Her refusal was accepted without comment. At dinner time and thereafter she took her seat without objecting. As the food she was served was entirely different from what she was accustomed to getting, she had no undesirable attitudes built about it.

At the beginning we tried to appear disinterested in her eating but more concerned with her conformance to routine. By assuming this attitude we were able to direct the conflicts that were sure to arise over our newly imposed authority to routine matters and establish ourselves there, keeping the meal time situation free from unpleasant scenes. Later we used the drinking situation to further establish our dominance. This plan worked very well and while X had several slight tantrums and two long ones during her stay with us, she never had one at a meal. Her resistance at that time took the form of dawdling and playing with the food. One day we found it necessary to keep her at the breakfast table all morning because she wouldn't drink her milk. The next morning it took her 2½ hours to finish and after that she drank it in fairly good time.

It was not until the middle of the fifth week, after she had learned to swallow solids and we were insisting that she make use of her newly ac-

quired technique, that she put up a defense reaction other than dawdling while eating. She had learned that tantrums availed her nothing. (These tantrums were a response to the new situations. She did not have them at home.) She had also learned that sitting a long time over her food was ineffective. But she could still belch and gag and she thought she could still vomit. Although belching and

her dessert unless she swallowed one bite of the food objected to. She resented the method and responded by attempting to vomit—the first and only time the effort was made. Her surprise at learning that she could no longer vomit at will was almost as great as finding herself sent to bed without finishing her supper, for we never hesitated to deprive her of food when we thought her behavior called for that kind of disciplining.

Her progress was very rapid, and considered in periods of weeks, was steadily upward. (See figure 1.) She varied, however, considerably from day to day, as can be seen from table 1. The variation depended directly on the food served for the day, as she showed food preferences from the very beginning. The consistency of the food and the ease with which it could be swallowed influenced her choice to some extent but not entirely. Some of the foods she preferred most were the hardest for her to swallow, bacon and raw vegetables being the best examples.

Her smallest gain was during the fourth week, or immediately after she had discovered that she could initiate the swallowing movement and could make the food go down voluntarily. Up to this time she had stored the food in her cheek and all but that which was very soft or which melted in her mouth like graham crackers,—which she was able to swallow from the very beginning—was taken out again to make room for more. It was while she was eating fruit cut at dinner the eighteenth day that she realized what was happening in her throat when she made the

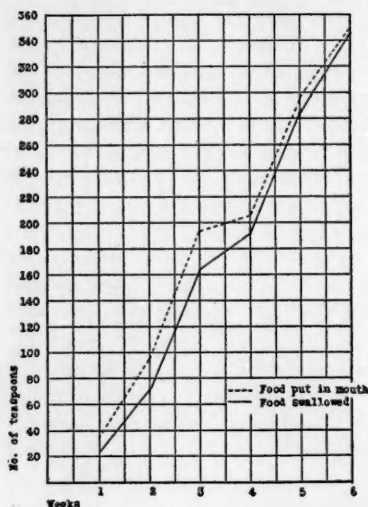


FIG. 1

gagging had disappeared entirely by the fourth week they reappeared the fifth week. She could now swallow all of the food that she put in her mouth but the effort required was still great. It was easier to spit out a bite from time to time than swallow all. In order to stop this tendency we began giving her extra servings in very small amounts—about $\frac{1}{4}$ teaspoon—and telling her that she could not have

coarser food go down. For the first time she realized what we meant when we told her to swallow her food. The days that followed were spent in trying to master the new technique. Although there was some increase over the preceeding week in the amount of food swallowed the biggest gain was in her control of the throat muscles.

The first foods she started eating were bacon and lettuce, then other raw vegetables and graham crackers. The crackers were the only foods she could swallow at this time. Whatever else was swallowed was by chance or with the aid of milk. In spite of her reputed aversion to sweets it did not take her long to discover that she liked desserts. On the sixth day she took a tiny bite of the thin tapioca custard that was served, exclaimed, "Dat good!" and ate three teaspoons of it. Before the end of the first week she also found that she liked whipped cream, baked bananas and apple sauce. Throughout the treatment we had to make use of these foods, particularly the bacon and desserts, to get her to taste other food she did not care for. Her diet during all but the last week and a half was greatly overablanded in favor of desserts and graham crackers, but since our first problem was to teach her the mechanics of swallowing and give her the right attitude towards food, we had to be guided by her choice and not by strict dietary regulations. Of all the food offered her, we encountered the most resistance to cereal and to eggs in any form except in her milk. They were served to her practically every day and by the sixth week we were beginning to overcome the prejudice. We tried out vitavose

TABLE 1
Summary of food intake, analyzed in terms of proteins, calories, calcium, phosphorus and iron

DAY	PRO- TEINS	CALO- RIES	CALCIUM	PHOS- PHORUS	IRON
	grams	grams	grams	grams	gram
1	0	0	0	0	0
2	9.3	217	0.231	0.295	0.0027
3	24.7	546	0.747	0.744	0.0048
4	23.4	518	0.729	0.670	0.0037
5	25.7	588	0.825	0.748	0.0039
6	20.7	487	0.630	0.595	0.0035
7	25.5	646	0.779	0.710	0.0038
8	25.4	635	0.779	0.708	0.0038
9	33.1	800	1.077	0.934	0.0044
10	29.3	722	0.877	0.858	0.0041
11	29.3	679	0.877	0.858	0.0041
12	29.4	734	0.929	0.822	0.0042
13	24.5	594	0.729	0.670	0.0037
14	22.7	585	0.630	0.595	0.0035
15	32.9	942	0.939	0.835	0.0047
16	15.0	424	0.325	0.426	0.0037
17	24.6	639	0.576	0.794	0.0040
18	28.7	630	0.731	0.965	0.0047
19	18.6	438	0.548	0.760	0.0037
20	19.9	682	0.457	0.589	0.0035
21	23.6	580	0.704	0.874	0.0044
22	26.2	478	0.615	0.601	0.0023
23	28.3	744	0.786	0.960	0.0047
24	33.3	792	0.881	1.059	0.0048
25	30.0	701	0.716	0.962	0.0053
26	15.9	436	0.474	0.539	0.0025
27	26.7	471	0.594	0.517	0.0031
28	26.5	662	0.766	0.945	0.0047
29	26.5	818	0.791	0.981	0.0051
30	26.9	723	0.750	0.973	0.0048
31	28.6	743	0.775	0.799	0.0038
32	36.8	1,090	0.982	1.289	0.0063
33	27.3	621	0.453	0.684	0.0056
34	41.9	1,107	0.969	0.910	0.0063
35	31.6	925	0.858	0.896	0.0062
36	36.4	1,131	0.872	0.891	0.0088
37	36.3	1,092	1.041	1.042	0.0067
38	29.6	832	0.725	0.744	0.0054
39	35.3	984	0.977	0.953	0.0071
40	35.1	1,037	0.978	0.967	0.0059
41	40.7	1,296	1.115	1.105	0.0087
42	28.8	855	0.754	0.749	0.0045

in her milk and beef broth before meals, thinking they might be helpful

as appetite stimulants but we met with so much resistance we dropped them. Adding salt to the food encouraged her to taste it, especially in the first weeks, but later was ineffective. In acquiring new tastes progress was slow, the food generally having to be served to her a number of times before she would eat it in any great amount. Sometimes after these trial periods she would find the food to her liking and at times she could be

eat changed from week to week and varied from meal to meal depending upon her behavior. At all times we were led by her. She was encouraged and praised frequently but never blamed for her inability to swallow solids. By the end of the second week we found that we had to use a certain amount of pressure but we always tried to keep our dominance from being overbearing. We were satisfied with very little at the beginning, but

TABLE 2
Comparative progress in food eaten

DAY	MEAL	FOOD SERVED	AMOUNT PUT IN MOUTH	AMOUNT SWALLOWED	NUMBER OF BITES
7	Dinner	Baked banana	1½ tsp.		18
		Pea souffle	½ tsp.	1½ tsp.	6
		Corn bread	½ tsp.		12
		Prune whip and	0 tsp.	0 tsp.	0
		Whipped cream	2 tsp.	2 tsp.	44
		Milk	½ pt.	½ pt.	
			4½ tsp.	3½ tsp.	
41	Dinner	Baked banana	6 tsp.	6 tsp.	17
		Liver souffle	3 tsp.	3 tsp.	17
		Lettuce sandwich	3 tsp.	3 tsp.	20
		Tapioca custard	9 tsp.	9 tsp.	29
		Milk and 2 tbsp. cream	½ pt.	½ pt.	
			21 tsp.	21 tsp.	

made to eat it in order to get a food she did like. As we considered it essential to keep her in the best condition possible, thinking that only in so doing would we make the best progress, we insisted upon a pint and a half of milk a day the first weeks and only cut it down when it began interfering with the amount of solid food she was eating. We added an egg yolk to the milk twice a day and later 2 tablespoons of cream once a day.

The methods used to induce her to

as she became more adept in her use of silver and in her ability to chew and swallow, we gradually were able to demand more and more of her. Reference to the chart shows how steadily upward her progress was in learning to handle solid food. While the swallowing technique had not become automatic, it was fairly well mastered by the end of 6 weeks. Only 3 teaspoons of food out of a total of 348 were not swallowed, compared to the 9 out of 34 that were removed the first week.

Although it was impossible to determine the exact amount swallowed it could be roughly estimated by comparing the amount served with the amount taken out of her mouth. The results shown in the tables can be considered as fairly accurate.

The foods she was eating with some enjoyment at this time were:

Bacon
Toast
Spinach
Apple sauce
Stewed prunes
Baked bananas
Graham crackers
Corn bread
Cottage cheese
Mashed potatoes

Rice
Peas
Sweet potatoes
 with apple sauce
Raw vegetables
 Lettuce
 Celery
 Spinach
 Cauliflower
 Cabbage

All simple desserts
 Tapioca custard
 Prune whip
 Fruit cup
 Cinnamon apples
 Grape gelatin
 Ice cream
 Cocoa blanc mange
 Baked custard
 Apricot whip
Whipped cream
After dinner mints

The foods she was learning to eat in substantial servings were:

Scrambled eggs and eggs in other forms
Stewed carrots
Oat meal and other cooked cereal
Rice flakes

The foods sampled, other than the ones mentioned above, were:

Chicken
Chicken dressing
Steak
Meat and vegetable loaf
Liver soufflé and liver in other forms

Tomato soup
Spinach soup
Beef broth
Salt cracker
Arrow root cracker

Egg plant
Corn meal
Noodles
Cake
Zwiebach
Jelly

She was not only eating these foods fairly willingly and with evidence of enjoyment for some of them but she was taking average size bites and was making good use of her lips and tongue in manipulating the food and getting it off the silver. Whether or not her subsequent progress in acquiring a healthy appetite and a keen enjoyment of food would have been as fast as her acquirement of the mechanics of the problem we do not know, as the parents decided to remove her from the school at this time. Their appreciation of her improvement was greater than their appreciation of the problem ahead. When she left us she had gained the 2 pounds lost the first few weeks and had gained an additional $\frac{3}{4}$ of a pound.

In evaluating the factors in the treatment that were most effective towards realizing the rapid progress in the short time, there are 3 main points that stand out above the others: (1) The complete separation from the

family, (2) the daily contact with normal children, and (3) the undivided control during the 6 weeks.

The follow up reports from the home have been unsatisfactory but a letter from the father 6 months later indicated that although she was still the dawdler she was when she left us, her gains in the mechanics of eating

had not been lost. He also reported some improvement in the amount of food she was eating and said that she was eating a larger variety than when she left us.

REFERENCES

- (1) ABR, I. A.: Anorexia in infants. *J. Dis. Child*, 1927, 33, 690.

Ability of Children in Color Discrimination

WILLIE MAE COOK

THE practical importance as well as the theoretical interest which is attached to color discrimination scarcely needs emphasizing. So essential is a normal color sensing mechanism that many individuals who are defective in this respect find themselves at a distinct disadvantage in numerous occupations and deprived of the keen esthetic satisfaction which most normal persons find in natural scenery, at the theater, and in many other situations in which color and color combinations are important features. Yet in spite of the great practical and personal importance of color discrimination, it is only within comparatively recent decades that it has become a matter of scientific consideration. Numerous common-sense hypotheses, based on crude observation, have been advanced to account for the physiological and psychological facts of color perception; but recent and more critical investigations have shown that virtually all of the traditional stock theories are either grossly erroneous or in need of serious revision. For example, it was until quite recently believed that defective color vision was more common in men than in women; in fact, it was regarded as a sex-linked characteristic; but improved tests have shown that if there are any sex differences at all in this respect, they are

indeed slight. It is also frequently asserted that color-blindness is more commonly found among adults than in children. However, this assumption, like many others, has been based upon only the most casual information concerning the actual color-sensing ability in children, and cannot be accepted until much more extensive and reliable data have been obtained. It appears, therefore, that the experimental study of color vision in children, especially at the early ages, is at present an especially fruitful field for research.

In the past, color vision in children has been studied mainly by the methods of color preference, color naming, and color matching. However, since the color preference has not proved especially productive as an experimental method, only the last two methods will be considered here. Again, contrary to the prevailing opinion, proficiency in color matching appears in children at an earlier age than does accurate color naming. Because of this chronological relationship, in the present study color matching will be considered before color naming both in the historical and experimental sections.

HISTORY OF COLOR DISCRIMINATION

No attempt will be made here to give a comprehensive survey of the previous studies of color matching and

color naming. This has been adequately done elsewhere (21, 2). However, it is desirable to review in some detail those investigations which have introduced especially unique or original methods and which seem to have obtained the most significant results. Many of the experiments here reviewed are not conclusive; nevertheless they serve to indicate productive methods and to suggest problems which are amenable to a more strictly quantitative and scientific approach.

Nagel (15) made observations on the development of the color sense of a child. His purpose was to find whether children of two and one-third years of age showed a normal trichromatic color sense, or whether there was any reason to assume a dichromatic or otherwise abnormal color vision. The subject was trained for 5 days to each of the colors red, green, blue, black, and white. The material was in the form of colored papers and was presented in several degrees of brightness and saturation.

The subject was seated before "the mosaic game." The experimenter pointed out red and had the child locate all of that particular color. At the second sitting he was presented with a large number of squares and asked, "Where is red?" The experiment was continued with each color for 5 days, with an average of three training periods per day.

Nagel concludes from his results with the one subject that a child learns to match red with red and green with green rather quickly; that the ability to match blue with blue and gray with gray develops more slowly. He draws no conclusions as to the

effect of brightness and saturation differences on color discrimination.

In investigating the color sense of his two children McDougall (13) found that by presenting flowers of different colors, worsted of different colors, and small boxes of different colors that he received a reaction to red as early as the fifth month. "The power to appreciate blue" seems to have appeared as early as the twenty-first week. His final conclusion is "that children are attracted more often by color than by brightness differences."

By means of what he calls the "grasp and reward" method Myers (14) desired to show what colors are confused with red, and to test the brightness sensitivity of his youngster. In the first series of experiments the subject was rewarded with a sip of honey each time she chose red when red was presented with any other color. In the second series presented with 2 gray cards of different brightnesses the child was trained to choose the brighter of the two. He claims to have found that at a very early age (perhaps long before six months) infants are susceptible to relatively small differences in brightness.

Among the other things noted by Woolley (22) in her study of the color perception of one infant is the influence of brightness difference on choice. In a series of colors used, yellow was the brightest color, green next, red third, and blue darkest. The order in which the child chose the colors from greatest to the least number of times was red, yellow, blue, and green.

The child's color preferences did not coincide with the brightness series

either in ascending or descending order. In so far as brightness differences influenced choice they must have tended to enhance the darker colors. These tests were made when the child was six months old.

Baldwin and Stecher (2) used the Holmgren color blind test series for a color discrimination experiment. The material consisted of 4 sample worsteds in the colors red, green, yellow, and blue together with 10 shades and tints of each color. Each sample was pinned to the lid of a gray box. In the lid was an opening $1\frac{1}{2}$ inches square to permit the worsteds being dropped out of sight. There was a row of red, green, yellow, and blue in the order named from left to right.

"It is obvious that the poor success of many children was not due to conditions of the test but to their stage of development. . . . The saturated greens were found to be the easiest and the pastel shades the hardest. Introspective and spontaneous remarks during the experiment showed that the children regarded the tints and shades such as pink and lavender as separate psychological entities, and were genuinely puzzled by the difference between the sample and the color to be placed."

The age scores increased from 10.3 per cent correct placements at two years to 12.3 per cent at three years, 22.5 per cent at four years, 38.5 per cent at five years, 35.8 per cent at six years. The correct placements at six years show a slight drop.

"The test measures functions that are relatively independent of the ability to name colors. . . . Some of the younger children could not name the four samples but placed a number of colors correctly. Other children could call even the more difficult shades and tints by their correct

names but could not place them. The test is a little too difficult for our youngest children, probably on account of the large number of colors to be sorted, which necessitates continuous attention for considerable time. It does test some rather complex process of discrimination and comparison, however, and it is consequently of value."

Baldwin and Stecher also conducted a card sorting test using colors from the Woodworth-Wells Blanks. The test materials consisted of a set of pasteboard trays about 1 inch by 2 inches and a pack of 100 cards. A color square cut from a Woodworth-Wells blank was mounted on each card. Each box was marked with a similar color square, and boxes arranged from left to right: yellow, black, green, red, and blue. Cards were piled on the table within a wooden frame and conveniently placed for the subject.

The instructions were: "See these little boxes and these little cards. Let's see how many of the cards you can put in the boxes, each card in the box marked with its own color. Just take any card that's on top and put it where there is one like it." A time limit was set at 5 minutes.

The authors say, "Success in this test is not altogether dependent upon the speed of muscular coordination. Some children hesitate a long time before placing a card, and make errors which they sometimes correct spontaneously, and sometimes recognize only when the experimenter took the wrong card out of the box in order to prevent confusion."

Descouedres (6), Brian and Goodenough (4), Tobie (20), and Eljasch (7) studied the relationship existing between form and color perception.

Descocudres' experiment involved the setting up of an experimental situation in which the subject was required to choose between two alternatives in matching a series of objects. Each situation offered equal opportunity for matching either on the basis of form or color, but a choice always had to be made.

Brian and Goodenough set up a similar problem for a group of subjects whose ages ranged from two years to sixteen years of age, and a group of 40 adult women. They found that up to the age of six years matching was done primarily on the basis of color; after the age of six years matching was done primarily on the basis of form.

Eljasch confirms the findings of the earlier investigators that the majority of children between the ages of three and seven years when confronted with the task of matching geometrical figures match them on the basis of similarity in color. "This predominance of color is found no matter whether size or form is the completing characteristic of the objects to be compared."

Tobie's investigation, published in 1927, is one of the most careful experiments reported on the reciprocal effects of color and form. His object was to determine whether children respond more readily to color or to form. Using about 1,000 subjects, he required each to select from an array of different forms, every one of which might appear in several different colors, those which are like the form of a specific color displayed by the experimenter. The records showed whether color alone, form alone, or the correct combination of both factors deter-

mined the selections made by the child.

Geometrical forms and outlines of familiar objects were both used as material. The principle conclusions of this investigator were summarized as follows:

"(1) Up to the age of 3 years 8 months the relative obtrusiveness of color and form determine to which of these factors the child will respond, i.e. which of them will be 'abstracted.' (2) In the age range from 3 years 9 months to 5 years 1 month the child tends to respond to color rather than to form. In the last months of this range the 'color zone' gives way to a period in which form is heeded more frequently. (3) With age 5 years 1 month a developmental phase begins in which, with increasing intellectual development, the ability to respond selectively to either form or color appears."

Conflicting evidence as to the age at which the color names appear in the vocabulary of the child are reported in numerous published studies dealing with the development of color perception. Several investigators experimenting with groups of children, largely European, stated that accurate color naming was acquired rather late. Among this group Binet and Simon (3) considered the correct naming of red, green, yellow, and blue an adequate test for the eighth year. In a later revision of the Binet Scale they placed it in the seventh year. Bobertag (8) replaced it in the eighth year. In America Terman and Childs (19) found it much too easy for the eight year old and in their tentative revision placed it in the fifth year.

Bateman's (1) study, published in 1915, includes the most comprehensive historical summary of the literature on

color naming up to that date. Since his experimental work was very carefully executed, both the general discussion and the conclusions which Bateman gives are of particular significance.

- His general discussion on color naming may be briefly summarized as follows: (1) Although not usual, children may begin to use color names as soon as the sixteenth month; (2) the twentieth month is about the average time at which color names at first appear; (3) aptness in acquiring further color vocabulary seems to vary with individual ability; (4) purple, green, and orange are first correctly named around the eighth or ninth year; (5) children as young as twenty-two months name the Binet colors unhesitatingly; (6) American results and foreign results on ability of young children to name colors are not in harmony; (7) boys show less ability at color discrimination than girls.

The final conclusions from the 591 subjects tested by Bateman are that the Binet color test is rightly placed in the fifth year, that school training increases color naming ability, that recognition and naming of colors is weakest in the cases of orange and purple, and that it is probable that American children could be taught to name the Binet colors correctly by the fourth birthday.

Garbini (8), following the same methods of the American and German experimenters, tested 600 six year old Italian children. His results indicate that only 35 per cent could name blue, yellow, pink, orange, and violet correctly.

Baldwin and Stecher (2) also tested

the strength of association of color names as determined by the ability to recall the names of color squares. Forty-eight children from three to six years of age were required to name 50 of the colors as given on the Woodworth-Wells color sheets, including red, green, yellow, blue, and black. Nine of the 48 children did not succeed in learning the names well enough to take the test. The time required for naming 50 colors averaged 159.7 seconds at 3 years, 142.1 seconds at 4 years, 92.4 seconds at 5 years, 92.1 seconds at 6 years.

Data from 38 subjects on naming the common signal colors were provided by Luckiesh and Moeller (11). Lights emitting dominantly red, yellow, green, blue-green, and blue were viewed singly and in a group. "The results showed that color names are not standard for a group of observers; that more confusion exists when the color is viewed singly than when viewed in a group of other colors; that the most confusion in naming is found for colors in the vicinity of blue-green; and that confusion also exists at the transitional point between red and yellow."

Interesting results as to the development of the color vocabulary may be had from a study of the vocabulary and language studies published during the last fifty years. Miss Shinn reports that her niece used red at the age of 16 months, Bohn's (1) child used green and yellow at 17 months, and Pelsma's (1) 18 month old child "recognized" blue. The studies of vocabularies of young children throw light on the development of ability to name colors. Bateman (1) has

summarized fifteen of the specialized color vocabulary studies.

It may be seen, from the literature which has just been reviewed, that many of the previous studies of color discrimination in children have been either sporadic and unsystematic or have been merely incidental features of juvenile biographies or of various types of mental tests and vocabulary studies. Many of the experiments lack scientific validity because of their failure to control the experimental conditions adequately and because of a lack of standardized materials and procedure. Several commercial concerns are now prepared to supply uniform and standardized color materials which make possible a degree of comparison of the results of various investigators and insure a reliability of results not hitherto attainable.

PROBLEM AND PROCEDURE IN THIS INVESTIGATION

The specific problem of this investigation was the determination of the child's responses to color specimens of different hues but of equal brightness and saturation and to specimens of the same hue but of different brightness or saturation. Both verbal and non-verbal discriminations were tested by the respective methods of color naming and color matching. As a supplementary problem, an attempt was made to ascertain whether the naming and the matching of different hues were facilitated or hindered by controlling the factors of saturation and brightness.

Subjects

The 110 children who were used as subjects consisted of 45 girls and 65

boys whose ages ranged from seventeen months to six years. General information about the groups may be given briefly as follows:

SOURCE	NUMBER OF SUBJECTS		
	Boys	Girls	Total
1. The Johns Hopkins' Child Institute.....	34	16	50
2. University of Georgia Nursery School.....	16	12	28
3. Roosevelt Recreation Center School.....	10	12	22
4. Good Will Industries Day Nursery.....	5	5	10
	65	45	110

	AGE RANGE		I. Q. RANGE
1	2 yrs. 1 mo. to 5 yrs. 4 mos.		97-168
2	2 yrs. 5 mos. to 4 yrs. 11 mos.		85-148
3	1 yr. 5 mos. to 5 yrs. 8 mos.		67-121
4	3 yrs. 10 mos. to 6 yrs. 0 mo.		72-105

Materials

Red, green, yellow, and blue squares of colored paper, $1\frac{1}{2}$ inches by $1\frac{1}{2}$ inches, which had been obtained from the Munsell Color Company and which had been mounted on gray pasteboard cards, 3 inches by 4 inches, were used for both the naming and the matching tests.

The materials employed in the preliminary series consisted of four such colors which any person with normal vision would have called red, green, yellow, and blue. The evaluation of each of these colors, according to the Munsell scale (12), is as follows: red, 4/14; green, 5/8; yellow, 8/14; and blue, 4/8. Two cards for each of the values were used.

The samples used in Series 1 and Series 2 were of various degrees of

brightness and saturation. They were made up of red, green, yellow, and blue hues. Munsell gives the following tabular illustration of the relationship between the different brightness and saturation values of these samples:

	6/4	
5/2	5/4	5/6
	4/4	

In both the vertical and the horizontal columns, the numerators represent the brightness values; the denominators, on the other hand, represent the saturation values. Thus, for the samples of any given color, the values in the horizontal row represent variations in saturation; the values in the vertical row likewise represent variations in brightness.

The materials for Series 3 consisted of 8 Holgate three-inch color cubes. Two cubes were painted red, two yellow, two green, and two blue. No attempt was made to determine the amount of brightness and saturation of the colors.

Throughout the experiment the accessory gray cardboard used was matched with the gray at the 4/5 value in the Munsell series. The table on which the cards were displayed was always completely covered by a gray cardboard, 22 inches by 28 inches.

Method

Preliminary series. Each subject was brought into the experimental room alone and seated at a small table covered with gray cardboard. Upon this were already placed the four colors which were later to be matched although they were tem-

porarily hidden from the view of the subject by a large piece of gray cardboard. The red sample was placed at the subject's left, the green one next, then the yellow one, and lastly on the extreme right, the blue one. The sample cards to be matched were given to the subject in the same order, i.e., red, green, yellow, and blue.

No attempt was made to equalize the brightness or saturation of the colors used in this series, the only purpose being to present colors which likely would have been frequently encountered by the child in every day experience and to orient the child toward the experiment. The child was first given the red card and instructed to find the color like it among the 4 cards already on the table.

The actual instructions given each subject were as follows: "I have some colors here. See? (Here experimenter removed the gray cardboard covering from the four colors and pointed to them.) Here is another color, too. (Experimenter removed the gray cardboard cover from the red sample card which was directly in front of the subject.) This color is like this one, (experimenter pointed from the sample red card to the red card on the table at the subject's left), isn't it?"

The experimenter took up the red card from the table and said, "Do you see that this card is like this one?" (Experimenter pointed to the sample card and then to the card on the table which the sample card matched.) The red sample card was then removed and the other red card returned to its proper position in the

row on the table. The colors were covered again. The green sample was then placed on the table below the row of four colors. Both gray covers were removed. It will be noted that covers were kept over all colors except during the actual presentation of a sample and its matching by the subject. The experimenter said, "See! Another color! Find the color like this one for me. You may pick it up."

If the subject responded correctly, approbation was shown by the experimenter's saying, "Fine!" or, "That's right!" If the subject made an incorrect judgment, it was indicated by the experimenter's shaking her head and saying, "No! No! This (pointing to the sample card) and this (picking up the correct card from the row and placing it by the sample card)! You see this color (pointing to the sample color) is just like this one (pointing to the green just placed beside the sample color)."

When the matching had been completed, the experimenter asked, "What color is this (pointing to red)? And this (pointing to green)? And this (pointing to yellow)? And this (pointing to blue)?" If no response was obtained to the first question, the experimenter said, "I am sure that you know what this color is. What name do you call it?" A record of both matching and naming was kept for this, the preliminary series.

Series 1. The object of this series was to determine the subject's ability to match hues which were varied in brightness and saturation. The six parts of the experimental procedure may be outlined briefly as follows:

Part 1. Four cards, differing in hue, but of the same brightness and saturation (value $5/4$).

Part 2. Same as part 1, but a higher brightness value, $6/4$.

Part 3. Same as part 1, but a lower brightness value, $4/4$.

Part 4. Same as part 1 in all details.

Part 5. Same as part 1, but with a higher saturation value, $5/6$.

Part 6. Same as part 1, but with a lower saturation value, $5/2$.

Series 2. The purpose of this second series was to determine the subject's ability to match colors when hue and brightness were constant and saturation varied, and secondly, when hue and saturation were constant and brightness varied. In the first part of the series three red cards of equal saturation ($5/4$) but of brightness values of $6/4$, $5/4$, and $4/4$ respectively, were exposed. A fourth card, with a brightness value of $6/4$, was then presented and the subject asked to match it with one of the three cards already on the table. This done, cards of $5/4$ and $4/4$ brightness value were matched. This procedure was then repeated with saturation instead of brightness as the variable. Parts two, three, and four of Series 2 were exactly like part one except that green, yellow, and blue were used instead of red. No naming was required in this series.

Series 3. This third series of the experiment was planned to check whether or not a position habit had been formed in the color naming and matching. The color cubes were presented in various spatial arrangements. The conditions were as follows: The

subject, after entering the experimental room, was seated at the table on which were placed the four colored cubes already covered with gray cardboard. Presenting the subject with the sample red cube and removing the covers from those already on the table, the experimenter said, "I have some blocks here. They are of different colors. This block in my hand is like this one here, (pointing to the red one on the table at the subject's left), isn't it?" As soon as the subject indicated his appreciation of the likeness, the experimenter removed the sample red cube. Following the same method as outlined in the procedure of the preliminary experiment, sample cubes of the colors green, yellow, and blue were presented respectively.

The color cubes were placed on the table in the same order as the color cards in Series 1.

The spatial arrangement of the cubes in the three succeeding presentations was changed. The child was required to match the four samples presented in the sequence: first presentation left to right, red, green, yellow, blue; second presentation left to right, green, red, blue, yellow; third presentation, yellow, blue, red, green; fourth presentation, blue, yellow, green, red.

At the end of the second and the fourth matchings of the four cubes, the subject was asked to name the colors. The particular presentations were arbitrarily chosen by the experimenter on the assumption that any memory habit for color naming would be indicated by his response to a different order of arrangement of the

colors on the table. No correction was made of errors throughout the whole of Series 3.

Four sittings were necessary for each subject to complete the preliminary and the three series of the experiment proper. The preliminary series and the first half of Series 1 occupied the first sitting. The second half of Series 1, all of Series 2, and all of Series 3 were given respectively on three subsequent occasions.

RESULTS

Color matching

The experimental situations of this investigation, as previously described, were designed to test the accuracy with which each subject could match color samples, as well as to test his ability to name the samples correctly. Color naming will be reported in the next section. Attention is here directed to the matching which was required in the Preliminary Series, Series 1, Series 2, and Series 3.

The purposes of the color matching tests were: (1) to find the relation between chronological age and the accurateness of color matching and (2) to determine the effect of changes in brightness and saturation, under carefully controlled conditions, on the matching of colors. The following graphic and tabular treatment of the data indicates the results obtained.

Table 1 gives the number and the percentage of correct responses made by the various age groups in both Series 1 and Series 2. The age groups represent six-month intervals, beginning with 2 years and ending with 6 years. The numbers in the double

TABLE 1

Total number and percentage of correct discriminations made by different age groups

AGE GROUP	NUMBER OF SUBJECTS	SERIES 1				SERIES 2			
		Brightness		Saturation		Brightness		Saturation	
		Number correct	Per cent correct	Number correct	Per cent correct	Number correct	Per cent correct	Number correct	Per cent correct
2 yrs. to 2 yrs. 6 mos.	8	51	53	53	55	33	34	36	39
2 yrs. 6 mos. to 3 yrs.	9	69	63	76	70	20	18	35	32
3 yrs. to 3 yrs. 6 mos.	14	156	92	147	87	90	53	85	44
3 yrs. 6 mos. to 4 yrs.	24	274	95	282	98	223	77	191	66
4 yrs. to 4 yrs. 6 mos.	24	287	99	287	99	234	81	232	80
4 yrs. 6 mos. to 5 yrs.	23	256	100	256	100	228	89	166	65
5 yrs. to 5 yrs. 6 mos.	5	60	100	60	100	51	85	50	84
5 yrs. 6 mos. to 6 yrs.	3	36	100	36	100	35	97	33	91

TABLE 2

Percentage of correct matchings as made by 110 subjects on combined scores of Series 1 and Series 2

AGE GROUP	NUMBER OF SUBJECTS	BRIGHTNESS		SATURATION		TOTAL	
		Number	Per cent	Number	Per cent	Number	Per cent
2 yrs. to 2 yrs. 6 mos.	8	84	43	89	46	173	45
2 yrs. 6 mos. to 3 yrs.	9	89	41	111	51	200	46
3 yrs. to 3 yrs. 6 mos.	14	246	73	232	69	478	71
3 yrs. 6 mos. to 4 yrs.	24	497	86	473	82	970	84
4 yrs. to 4 yrs. 6 mos.	24	521	91	519	90	1,040	90
4 yrs. 6 mos. to 5 yrs.	23	484	94	422	82	906	82
5 yrs. to 5 yrs. 6 mos.	5	111	91	110	91	221	91
5 yrs. 6 mos. to 6 yrs.	3	71	98	69	95	140	97

TABLE 3

Percentage of correct matchings for each color according to age groupings

AGE GROUP	NUMBER OF SUBJECTS	PRELIMINARY SERIES				SERIES 1				SERIES 2				SERIES 3			
		Red	Green	Yellow	Blue	Red	Green	Yellow	Blue	Red	Green	Yellow	Blue	Red	Green	Yellow	Blue
2 yrs. to 2 yrs. 6 mos.	8	25	62	50	25	48	60	58	50	33	35	35	39	31	53	62	31
2 yrs. 6 mos. to 3 yrs.	9	66	55	88	66	74	66	72	55	40	13	22	28	60	55	72	66
3 yrs. to 3 yrs. 6 mos.	14	93	93	86	86	89	92	89	89	60	47	47	52	84	82	82	84
3 yrs. 6 mos. to 4 yrs.	24	87	96	96	87	95	97	98	90	75	65	64	66	86	89	89	88
4 yrs. to 4 yrs. 6 mos.	24	100	100	100	100	99	100	99	100	86	80	80	79	100	100	100	100
4 yrs. 6 mos. to 5 yrs.	23	100	100	100	100	100	100	100	87	74	80	70	100	100	100	100	100
5 yrs. to 5 yrs. 6 mos.	5	100	100	100	100	100	100	100	83	93	73	86	100	100	100	100	100
5 yrs. 6 mos. to 6 yrs.	3	100	100	100	100	100	100	100	88	100	100	83	100	100	100	100	100

columns with the word "Brightness" at the top indicate the number and percentage of correct responses when saturation was the variable; the numbers in the columns headed "Saturation," on the other hand, indicate the

shown in table 2 appear. This table gives the total number and percentage of correct matchings made by all the subjects on the combined scores of the two series. The percentage of accurate judgments as given in the table

TABLE 4

Percentage of correct matchings of red, green, yellow, and blue for each age group based on combined scores of Preliminary Series, Series 1, 2, and 3

	AGE GROUPS								AVER- AGES
	1	2	3	4	5	6	7	8	
Red.....	37	58	70	85	98	95	94	100	84
Green.....	50	44	71	84	94	90	98	100	81
Yellow.....	51	55	64	85	93	92	90	100	82
Blue.....	40	49	72	82	92	89	95	100	81

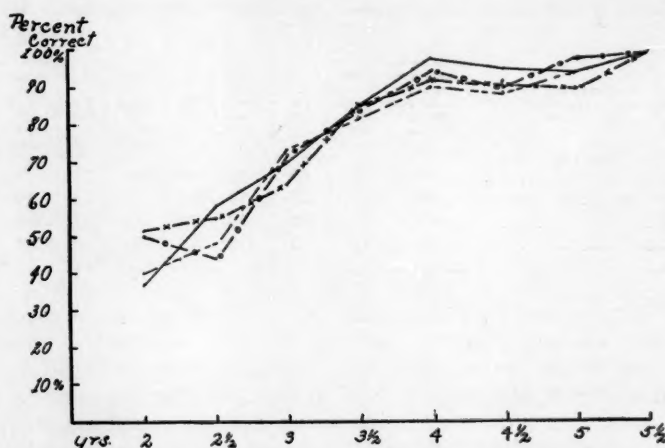


FIG. 1. PERCENTAGE OF CORRECT MATCHINGS OF SUCCESSIVE AGE GROUPS. BLUE---; GREEN—o—o; YELLOW—x—x; RED—

number and percentage of correct responses when brightness was the variable.

When the scores for brightness difference tests and for saturation difference tests for both Series 1 and Series 2 are combined, the results

indicates a continuous increase in the proportion of correct color matchings with an increase in chronological age.

The percentage of correct matching for each of the four different hues is given in table 3. This summary is made from all four series. The results

indicate that an upward progression of chronological age increases the chances for correct color matching, though not in any direct ratio. With the exception of red in one series (Series 2), no color is matched consistently better or worse by the successively age groups.

In order to summarize concisely the combined scores as obtained on the Preliminary Series and on Series 1, 2, and 3 for color matching, table 4 and Figure 1 are presented. The numbers indicate that the average accuracy for matching for each of the colors is: red

accurately when saturation is constant and brightness is varied rather than when brightness is constant and saturation is varied.

Color naming

This section deals with an analysis of the naming of the four primary colors by 110 children. The oldest child tested was 6 years, the youngest 2 years and 1 month. Age was reckoned to the nearest month on the day the first test was given.

Each child was required to give the four color names included in the Binet

TABLE 5

Number of percentage of correct responses obtained for each of the primary colors

TESTS FOR COLOR NAMING USED IN PRESENT EXPERIMENT	NUMBER OF POSSIBLE CORRECT NAMES FOR EACH COLOR	RED		GREEN		YELLOW		BLUE	
		Total number of correct names	Per cent	Total number of correct names	Per cent	Total number of correct names	Per cent	Total number of correct names	Per cent
Binet.....	94	57	60	62	66	67	71	58	62
Preliminary.....	110	85	77	74	67	68	62	79	72
Series 1.....	660	386	58	416	63	309	47	484	73
Series 3.....	220	154	70	132	60	151	68	133	60

84 per cent, yellow 82 per cent, and both blue and green 81 per cent. These percentages are obtained by combining the results for all age groups and of each of the experimental situations (including hue, brightness, and saturation as variables).

In general it appears from the data obtained on color matching that accuracy in color matching increases with an increase in chronological age and that no color is consistently matched most accurately by succeeding age groups. There is slight indication, however, that the tendency is present to match colors more

test as well as to name the colors used in the three experimental situations set up by this investigation. The method of giving one point for each color correctly named was arbitrarily adopted as a scoring device. A correct score was given only when the color specimen was called by its right name, i.e., either red, green, yellow, or blue. This procedure was adhered to throughout the experiment.

Table 5 summarizes the number and percentage of correct responses obtained for each of the primary colors in the Binet test and in the three experimental situations involving color

naming. A careful scrutiny of this table reveals the fact that the per-

TABLE 6

Correlations between the correct responses obtained from Binet, Preliminary, Series 1 and Series 3

TESTS	CORRELATION	P.E.
Binet and Preliminary.....	.766	.0287
Preliminary and Series 3...	.88	.015
Combined Preliminary and Series 3 with first half of Series 1.....	.89	.013
Combined Preliminary and Series 3 with second half of Series 1.....	.89	.014
First half of Series 1 with second half of Series 1....	.92	.0001

centage of correct responses for the preliminary test was higher, on the average, than the percentage of correct responses for the other two color naming tests of this investigation and the color naming on the Binet.

The correlations between the correct responses obtained from these four test situations are given in table 6. These figures indicate a high degree of similarity between the situations under investigation.

In order to arrive at a more concrete notion of the color naming ability of the various age groups, the correct scores for the Preliminary Series, Series 1, and Series 3 were totaled. Subjects grouped according to chrono-

TABLE 7

Average number and percentage of correct naming for the four colors

SUBJECTS GROUPED ACCORDING TO CHRONOLOGICAL AGE	AVERAGE CHRONOLOGICAL AGE	NUMBER OF SUBJECTS	AVERAGE NUMBER OF CORRECT NAMES GIVEN FOUR COLORS	PERCENTAGE OF CORRECT NAMING
2 yrs. to 2 yrs. 6 mos.	2 yrs. 3 mos.	8	8.2	25
2 yrs. 6 mos. to 3 yrs.	2 yrs. 7 mos.	9	12.1	35
3 yrs. to 3 yrs. 6 mos.	3 yrs. 2 mos.	14	15.4	47
3 yrs. 6 mos. to 4 yrs.	3 yrs. 8 mos.	24	17.7	56
4 yrs. to 4 yrs. 6 mos.	4 yrs. 2 mos.	24	26.4	81
4 yrs. 6 mos. to 5 yrs.	4 yrs. 7 mos.	23	24.3	75
5 yrs. to 5 yrs. 6 mos.	5 yrs. 2 mos.	5	18.0	56
5 yrs. 6 mos. to 6 yrs.	5 yrs. 9 mos.	3	20.4	62
SUBJECTS GROUPED ACCORDING TO MENTAL AGE	AVERAGE MENTAL AGE	NUMBER OF SUBJECTS	AVERAGE NUMBER OF CORRECT NAMES GIVEN FOUR COLORS	PERCENTAGE OF CORRECT NAMING
2 yrs. to 2 yrs. 6 mos.	2 yrs. 2 mos.	3	5.6	15
2 yrs. 6 mos. to 3 yrs.	2 yrs. 8 mos.	10	7.5	21
3 yrs. to 3 yrs. 6 mos.	3 yrs. 2 mos.	8	12.1	31
3 yrs. 6 mos. to 4 yrs.	3 yrs. 9 mos.	17	12.2	34
4 yrs. to 4 yrs. 6 mos.	4 yrs. 2 mos.	21	14.7	90
4 yrs. 6 mos. to 5 yrs.	4 yrs. 8 mos.	20	27.1	93
5 yrs. to 5 yrs. 6 mos.	5 yrs. 2 mos.	17	28.0	78
5 yrs. 6 mos. to 6 yrs.	5 yrs. 9 mos.	8	28.7	80
6 yrs. to 6 yrs. 6 mos.	6 yrs. 2 mos.	6	26.3	73

logical age and according to mental age, the number of subjects in each group, the average number of correct names given the four colors, and the percentage of correct naming are given in table 7.

It will be noted that in both the successive chronological age groups and the successive mental age groups the color naming is most accurate in the 4 year 6 month to 5 year group

scores are consistently lower than in the corresponding mental age groups.

The fact that red is named most accurately by the youngest and the oldest subjects is shown in Figure 2. Blue maintains a high degree of accuracy with greatest consistency. Yellow is named least accurately by each of the age groups. Green, beginning with a very low percentage of correct responses, increases in accuracy

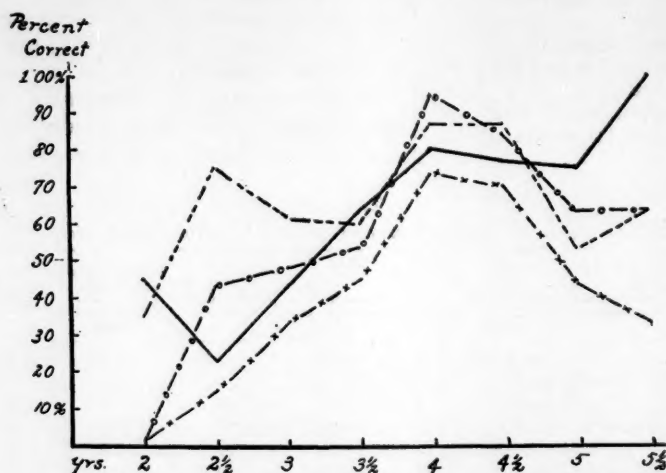


FIG. 2. PERCENTAGE OF CORRECT NAMING FOR EACH COLOR ACCORDING TO SUCCESSIVE AGE GROUPS. BLUE—---; GREEN—○—; YELLOW—x—x; RED—

and decreases after this age. A possible explanation for the drop lies in the fact that at this age the child begins to add numerous color names to his vocabulary other than the elementary names. As a result he may frequently call red, green, yellow, and blue the various tints and shades of these colors, and in so doing is accordingly deprived of credit. In the last four chronological age groups the

up to the fifth group and ends on an equality with blue. The data represented by Figure 2 are based on the total number of correct names given each color in the Preliminary Series, Series 1, and Series 3.

The effects of brightness and saturation differences on color naming are revealed in table 8. At the ages of 2 years to 2 years 6 months and from 3 years to 4 years 6 months a higher

TABLE 8
The effect of brightness and saturation differences on color naming

AGE GROUPS	NUM- BER OF SUB- JECTS	SATURATION DIFFERENCE (NUMBER CORRECT)		BRIGHTNESS DIFFERENCE (NUMBER CORRECT)		RED			GREEN			YELLOW			BLUE		
		Total	Per cent	Total	Per cent	Total	Per cent	Total	Total	Per cent	Total	Total	Per cent	Total	Total	Per cent	Total
2 yrs. to 2 yrs. 6 mos.	8	23		24	24	10	42	10	42	0	0	2	8	1	4	12	50
2 yrs. 6 mos. to 3 yrs.	9	44	40	41	37	6	22	5	18	12	44	11	40	7	28	19	70
3 yrs. to 3 yrs. 6 mos.	14	78	41	82	49	18	43	17	40	15	36	20	47	18	43	27	64
3 yrs. 6 mos. to 4 yrs.	24	152	53	161	56	45	62	42	58	41	57	37	51	26	36	32	44
4 yrs. to 4 yrs. 6 mos.	24	230	79	232	80	53	73	54	75	68	94	66	91	47	65	62	86
4 yrs. 6 mos. to 5 yrs.	23	211	76	201	72	49	71	40	58	56	81	58	84	46	66	41	59
5 yrs. to 5 yrs. 6 mos.	5	35	58	33	55	10	66	9	60	9	60	9	60	7	46	6	40
5 yrs. 6 mos. to 6 yrs.	3	24	66	24	66	9	100	9	100	6	66	6	66	3	33	6	66

percentage of correct naming of colors is made with saturation as the constant and brightness as the variable. The 2 year 6 months to 3 year olds, and the 4 year 6 months to 5 year 6 months react with correct color names

TABLE 9

Total number of color names given each of the four primary colors by the eight age groups

	AGE GROUPS							
	2½	3	3½	4	4½	5	5½	6
Red.....	5	4	9	9	7	6	6	3
Green.....	6	5	8	9	6	7	7	4
Yellow.....	6	5	9	8	10	7	7	6
Blue.....	5	4	8	8	6	6	9	6

to each of the four primary colors by the eight different age groups. With an increase in chronological age there is a sporadic increase in the number of color names in the vocabulary.

From the data obtained on color naming the following results appear to be clear cut: (1) Accurate color naming ability increases with chronological age. (2) It may be predicted with a fair amount of certainty that individuals who receive a high score for color naming as measured by any one of the methods used in this investigation will also receive a high rating on all the other naming tests here used. (3) Individuals within the

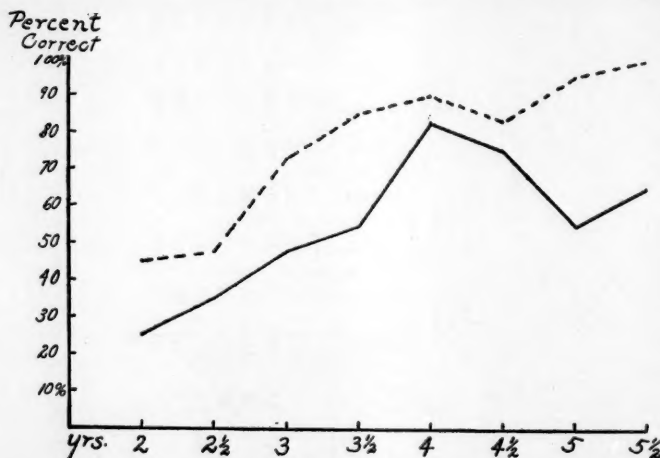


FIG. 3. PERCENTAGE OF CORRECT MATCHING AND NAMING OF ALL THE COLORS BY THE SUCCESSIVE AGE GROUPS. MATCHING-----; NAMING——

more accurately when brightness is the constant factor and saturation is the variable.

Concluding the results on color naming, in table 9 is presented the number of different color names given

same age group show wide variation in score, e.g., the range in score within 2 year to 2 year 6 months group was from 0 to 30. (4) The children, within the age range studied are likely to call one of the sample primary

colors by its own name or by the name of any shade or tint of any primary color. Furthermore, the results of this investigation indicate that there is a tendency to name colors more accurately when saturation is the constant factor and brightness is the variable.

Color Naming and Color Matching

The data obtained for color naming and color matching may be compared in certain respects. When a comparison of the raw scores for naming and matching of colors is made, it is found that in both cases there is a relatively greater number of high scores than low scores. There is a greater frequency of low scores for color naming than for color matching. There is also an indication of a higher correlation between the upper range of scores for naming and matching than between the lower range of scores.

Figure 3 gives the percentage of correct scores for naming and matching colors as obtained with the 110 subjects divided into groups on the basis of age. That color matching received a consistently higher percentage of correct scores than color naming is also indicated.

SUMMARY

On the basis of the data included in the foregoing study of color naming and color matching, the following statements appear to be true:

1. By the age of two years, children are able to match color specimens which differ in hue, brightness, or saturation, with an accuracy of 45 per cent and to name the four primary colors, red, green, yellow, and blue, with an accuracy of 25 per cent. By the age of six years, these two abilities have increased respectively to 97 per cent and 62 per cent.
2. These abilities, however, do not increase uniformly with age, the four-year-olds doing practically as well as the six-year-olds in the color matching and actually excelling them by almost 20 per cent in the color naming. This last fact may be due in part to the relatively lower mental ages and small number of cases in the upper age ranges and in part to the tendency on the part of the older children to use names of related hues, for example, such words as pink, magenta, rose, and scarlet for red, which naturally resulted in a lower naming score in some cases. The training of the child in color discrimination is probably an influential factor in the differences shown within an age group.
3. Although no comprehensive study of color vocabularies was made, there appears, as would be expected, a general increase in number of color words with increasing age.
4. Children of the ages ranging from two years to six years consistently match colors more accurately than they name them.
5. Children of each age can discriminate more accurately between differences in hue than between differences in either brightness or saturation.
6. There appears to be no significant difference in ability to discriminate between brightness and saturation differences, although there is a negligible tendency on the part of the group as a whole to discriminate brightness differences more accurately.
7. There is no regularity in the order

of accuracy with which successive age groups name or match the colors red, green, yellow, and blue. Although one age group may match red, for example, more accurately than

any other color, another age group may match another color most accurately. There is, however, no consistent tendency to give one color precedence over the others.

REFERENCES

- (1) BATEMAN, W. G.: The naming of color by children: The Binet test. *Ped. Sem.*, 1915, **22**, 467-486.
- (2) BALDWIN, B. T. and STECHER, L. I.: The psychology of the preschool child. New York.: D. Appleton, 1925, 125-128.
- (3) BINET AND SIMON: Le développement de l'intelligence chez les enfants. *L'Année Psychol.*, **14**, 1-94.
- (4) BRIAN, C. R. AND GOODENOUGH, F. L.: The relative potency of color and form perception at various ages. *Jour. of Exper. Psychol.*, **12**, 197-213.
- (5) BUSH, A. D.: The vocabulary of a three year old girl. *Ped. Sem.*, 1914, **21**, 125-142.
- (6) DESCOEUDRES, ALICE: Couleur, forme ou nombre? *Arch. de Psychol.*, 1914, **14**, 305-341.
- (7) ELJASCH, M.: Neue Abstraktionsversuche bei vorschulpflichtigen Kindern. *Zsch. f. Psychol.*, 1927, **106**, 22-41.
- (8) GARBINI, A.: Evoluzione del senso cromatico nei bambini. *Arch. per l'Antr.*, 1894, **24**, 71-88.
- (9) GODDARD, H. H.: Two thousand normal children measured by the Binet scale of intelligence. *Ped. Sem.*, **18**, 232-259.
- (10) HALL, G. S.: Contents of children's minds on entering school. *Ped. Sem.*, **1**, 139 ff.
- (11) LUCKIESH, M. AND MOELLER, I. W.: Naming the common signal colors. *J. Opt. Soc. Amer.*, 1926, **13**, 465-469.
- (12) MUNSELL, A. H.: A color notation. 7th edition. Hoffman Bros. Co., 1926.
- (13) McDOUGALL, W.: An investigation concerning the color sense of two children. *Brit. J. of Psychol.*, 1906-1908, **2**, 333-352.
- (14) MYERS, C. S.: Some observations on the development of the color sense. *Brit. J. of Psychol.*, 1906-1908, **2**, 353-362.
- (15) NAGEL, W. A.: Observations on the color sense of a child. *J. of Comp. Neur. and Psychol.*, 1906, **16**, 217-230.
- (16) NICE, M.: The development of a child's vocabulary in relation to the environment. *Ped. Sem.*, 1915, **22**, 35-63.
- (17) NICE, M.: Speech development of a child from eighteen months to six years. *Ped. Sem.*, 1917, **24**, 204-243.
- (18) SHINN, M. W.: Notes on the development of a child. *Univ. of Calif. Publications in Educ.*, 1893-1899, **1**.
- (19) TERMAN AND CHILDS: A tentative revision and extension of the Binet Simon scale of intelligence. *Jour. Educ. Psychol.*, **3**, 61-74, 133-143, 198-208, and 277-289.
- (20) TOBIE, H.: Die Entwicklung der teilinhalten Beachtung von Farbe und Form im vorschulpflichtigen Kindesalter. Beihefte z. *Zsch. f. angew. Psychol.*, 1927, **38**, 103 ff.
- (21) TRACY, F.: The psychology of childhood. Boston, 1909.
- (22) WOOLLEY, H. T.: Some experiments on the color perception of an infant and their interpretation. *Psychol. Rev.*, 1909, **16**, 363-376.

Brief Reports

A Study of Hand and Eye Preference

PROBLEM

THE study here reported presents the results of a study of the hand and eye preferred by the children at the Vassar College Nursery School for the school year of 1929-1930.

An attempt was made to study the following problems: (1) Does a definite relationship appear between the preferred hand and the preferred eye in the group of young children studied? (2) Do the children in this group who have marked speech defects show a tendency towards left handedness? (3) Does the stability of hand preference show any relationship to the development of speech in the case of a twelve months old child, during the period of observation?

METHOD

1. Direct observations were made of the preferred handedness of 23 children at the nursery school. Most of the observations were made during the noon hour.

2. To twelve of these twenty-three children 3 tests were given in an attempt to determine eye preference. These tests were based on Walter Miles' (1) method for testing ocular dominance which seemed the most practicable for testing pre-school children. The apparatus consists of a V-scope or paper cone which is

pressed open by the subject with both hands. However, due to the inability of the children to squeeze the V-scope hard enough to keep the hole at the end of the cone of uniform size, embroidery rings were securely fastened into one of the V-scopes. Thus Miles' test was varied to the extent of using the same V-scope during the entire series of experiments, and the children were not told to lower the V-scope between tests. The subject holds the wide end of the cone over his face, looks into and through the cone at an object placed some feet away. The unconscious sighting is shown by the direction in which the tip of the cone is pointed. The subject has the impression that he is looking at the object with both eyes, but he is really focusing with one eye. This test has the advantage of doing away with errors due to preferred handedness, and seems to have high interest value for all the children who served as subjects.

The situations studied were as follows:

- a. In the first experiment Miles' set of ten silhouettes was used—a horse's head, a hand, a crescent, a bicycle, a circle, a cat, a girl's face, an owl, a rooster and a cross. These were placed on a level with the child's head and seven feet away from him. No artificial light was used. The responses of the children to the pictures were recorded as well as the

direction in which the tip of the V-scope pointed.

- b. In the second experiment the same silhouettes were used, but no attempt was made to show the pictures in the same order. An electric lamp was used to throw direct light on the pictures.
- c. The third experiment was given immediately after the second. Ten pictures cut from a magazine were

foot preference as shown in (a) foot lifted first in climbing stairs; (b) foot used on shovel in digging.

RESULTS

In table 1 the subjects are arranged according to age. Observations on the use of the fork and spoon are designated as follows: (1) R— for con-

TABLE 1

SUBJECT	OBSERVATIONS—HAND					EXPERIMENTS—EYE		
	Fork	Spoon	Unclassified	Foot	Shovel	Experiment 1	Experiment 2	Experiment 3
A	R-L-R	R	L	R				
B	R	R	R	R				
C	R	R	R	R				
D	R	R	R	R				
E	L-R	R	R			R	R	R
F	L-R	R	L or R	R or L	L-R+	L	L	L
G	R or L-R	R	R	L	L+-R	R	R	R
H	R	R	R			L	L	L
I	R	R	R		L-R			
J	L-R	R-L-R	L			R	R or L-R	R
K	R	R	R		L-R+	R-L	R	R
L	L	L	L	L		L-	L-	R-
M	R	R	R			R-	L-	L
N	R	R	R			R-	R-	R
O	R	R	R					
P	R	R	R					
Q	R	R	R		L-R+	R		R
R	R	R	R		L-R+			
S	R	R	R		R-L+			
T	R	R	R	L	L-R+			
U	R-L	L or L-R	L		R-L+	L	L	L
V	R	R	R					
W	R	R	R	L		R-	L	L

pasted on cards of the same size as those used for the silhouettes. Most of these were colored and all were shaded in contrast to the silhouettes shown in the first and second experiments.

3. Direct observations of use of a spade on the playground were made.
4. Direct observations were made of

sistent preference for right hand, (2) L— for consistent preference for left hand, (3) LR— for tendency to start with the left and end with the right hand, (4) RL— showing opposite tendency. Observations on the use of the shovel are recorded with the hand nearest the spade end first—a + sign over the hand directing the work. X

indicates some variation in preferred eye. LR indicates change of focus from left to right.

1. The age distribution of the children and the numbers tested for hand and eye dominance are indicated in table 2.

2. Table 3 gives the results of tests for hand and eye dominance.

TABLE 2
Chronological age levels

GROUP	AGE	NUMBER TESTED FOR HAND	NUMBER TESTED FOR EYE
	<i>months</i>		
I	18-24	1	0
II	25-36	4	1
III	37-48	7	6
IV	49-55	11	5

TABLE 3
Relation of hand to eye dominance

	NUM- BER OF CASES	EYE	HAND
Group II.	1	R	R
	2	R	R
	2	R	L
Group III.	1	L	R
	1	L	L
	2	R	R
Group IV.	2	R	L
	1	L	L

In the study of the question: "Is there a correlation between the increased stability of hand preference and the development of speech into words and syllables?" the subject, M H., was a girl observed from the age of twelve months through nineteen months. At the beginning of the observation M. H. was in the babble period and at the end of the experi-

ment M. H. had a vocabulary of fifty-three words. Running notes of M. H.'s use of a preferred hand were taken.

Included as subjects in this study were male fraternal twins, both classed as preferring the right hand, yet one shows preference for the left eye and the other for the right.

CONCLUSIONS

Of the twelve children tested both for hand and eye preference, five preferred the right hand and the right eye; five preferred the right hand and the left eye; one preferred the left hand and had a decided preference for the right eye; while another preferred the left hand and the left eye.

In the attempt to find whether there is a correlation between speech defects and the inhibited use of the preferred left hand, it was found that there was not sufficient material at the school to make any adequate study of the question. Subject L preferred the left eye sixteen times out of thirty tests. This results is inconclusive especially since the last list seemed to show L to prefer the right eye. At present, L has, if not a speech defect, unusually inarticulate speech for her age. In talking she speaks very fast, often omitting parts of words and final consonants. For example, L pronounces Grand Avenue as "Ja Aa"; for yesterday, L says, "ya-ye-daa." The results as shown in the tests seem to be typical of her temperament. At present the only statement as to a preferred hand which seems justified is that when L is given a choice the left hand is preferred. She especially prefers to use the left

hand in eating—changing the fork or spoon from the right to the left hand for all delicate eating operations.

Another subject who shows a tendency to prefer the left hand is being taught at home to use the right. No speech defect has resulted.

In regard to the question, "Does the stability of hand preference show any relationship to the development of speech in the case of a twelve months old child?" the observations indicated that as the subject, M. H. became more definitely right-handed, as shown by her use of the fork and spoon at the

table, she began to develop a vocabulary. M. H. seems to use her left hand as well as her right, but she prefers her right for eating, whereas in working with the pegboard and fitting toys together, she generally prefers the left hand. The period in which the use of the hands was developing was also one of rapid development of speech.

KATHERINE GORDON.

REFERENCES

- (1) MILES, WALTER: Ocular dominance demonstrated by sighting. *Jour. Exper. Psychol.*, 1929, 12, 113-126.

Speech and Music Development of a One Year Old Child

A LITTLE girl, M. H., was brought to the Vassar College Nursery School at the age of twelve months. At the school she came into daily contact with twenty-five other children. The youngest of these children was nearly a year older than she.

PROBLEM

In order to determine if possible whether there was any relationship between the rate and order of acquisition of speech and musical development, this child was observed and a careful running record kept of her responses.

PROCEDURE

Observations for this study were made from October, 1929 to May 15, 1930, that is between the age of thirteen and twenty months. M. H. was observed on an average of two or three times a week, usually in the afternoon, for about two hours at a

time. The sounds which she made were recorded, as well as the tone of these sounds. These records were dated. Efforts were made to encourage the child to speak. Sometimes something she wanted was withheld in an attempt to make her ask for it. Real and pictured objects were named over and over again in an effort to build up an association between the objects and their names. Questions were asked and pictures were shown. Sometimes the observer talked to her continually; on other days the observer remained as silent as possible.

Various victrola records were played for M. H., usually those of Kreisler, or some individual singer, so that the tune would be distinct and clear. Her reactions to these were observed. Simple tunes and melodies were sung for her and often repeated many times. Tunes which she hummed were repeated by the observer after her many

times. The observer sometimes beat out or jiggled rhythms for M. H. and her reactions were noted. Sometimes the observer attempted to slap out rhythms with M. H.'s hands.

SUMMARY OF RESULTS

The speaking and musical development of M. H. was observed from the age of twelve to nineteen and a half months. This included the babble period as well as the inception and development of speech. During this time her vocabulary grew from no words to fifty-three. These fifty-three words have all been heard and recognized as actually intended to apply to the objects which they designate. M. H.'s comprehension of words is, of course, much greater. She understands simple commands, provided they deal with a comparatively familiar situation. Although able to use her vocabulary M. H. will not speak before strangers or those who are not familiar to her; nor will she speak in unusual situations. Many people oppress and silence her; when playing alone she jabbars most of the time. Thus M. H. uses words to ask for and name things when she is with people whom she knows well, but for social purposes her speech is retarded. This retardation of speech for social purposes may be due to two things. It may indicate that she is shy or it may be due to the fact that in the school where the routine is so carefully planned out most wants can be satisfied without asking for them.

Many words, such as dolly and fish, were first spoken after the observer had named them for her repeatedly. Other words, such as cracker, rubber,

and block, were not repeated for M. H. consciously by the observer. However, she probably heard these words many times in general conversation during the year at the school.

Forty-four of the fifty-three words are nouns; Three interjections; two pronouns; two prepositions; one verb; and one adjective. This is to be expected since a vocabulary to be useful must include the names of articles desired. The two prepositions are often used as verbs.

Musically, the sounds M. H. made did not, at first, vary much in pitch, nor did they have much variety of tone. For the most part they ranged over the eight notes of the octave from middle C up.

M. H. showed a favorable and appreciative attitude toward music and rhythm of different sorts. Her spontaneous singing is quite melodious but not usually very rhythmic. She is not tone-deaf and seems to have a fair ear for music, although it is still much too early to judge definitely.

CONCLUSIONS

In any study such as this there are two important considerations. First, the acquisition of words themselves; second, the voice quality and pitch with which these words are uttered and the use made by the child of variations in pitch and quality.

M. H.'s speech and music development seem to be progressing normally. Her speech is comparatively clear, except for the fact that the final consonants are usually omitted. The "k" sound is seldom made, and "t" is often omitted when it occurs in the middle of a word. All the vowel sounds are

present. Her acquisition of vocabulary, while late in starting, now seems to be progressing rapidly. Her great interest in everything about her is an added incentive to further speech development.

Not very much can be stated definitely at this time concerning the musical development of M. H. This is due partly to her age. It can only be said cautiously that she appears to enjoy music and to be able to produce musical sounds.

Due to the nature of her vocabulary, M. H.'s speech is, as yet, almost entirely staccato, and therefore little

comparison can be made between her speech and rhythm. The individual words are tonal and pure.

Very little can be said, even tentatively, concerning the musical development of a child as young as M. H. It is possible that musical ability does not even develop until the pharyngeal opening of the Eustachian tube of the ear has risen from below the hard palate to above it. Whatever the case may be, one can devise only a few satisfactory experiments to test musical development in a child under two years of age.

MARGARET FITCHEN.

A Study of the Sleeping Habits of Twenty-nine Children of Pre-School Age

A STUDY was made of the daytime sleeping habits of children who had been members of Vassar College nursery school for a sufficient length of time to have become habituated to the daily routine. The time covered was the first semester of the academic year, 1929-1930.

The room in which the children slept was equipped with canvas cots laced both ways in order that the surface was tightly stretched; one sheet folded so that the child lay between the two parts; light weight wool blankets and extra cotton blankets to be used in cooler weather. There were low screens which might be used around the beds of children who needed for any reason to be isolated.

The subjects used in this study were twenty-seven in number. The ages used were computed to October 1, 1929 when the study was begun. The age

range was from one year and ten months to four years and five months and the distribution as follows:

AGE	BOYS	GIRLS	
22-30 mos.	3	0	
31-42 mos.	3	10	
43-53 mos.	7	4	
Total.	13	14	27

PURPOSE

The study was undertaken with the purpose of adding, if possible, to information on the following points:

1. Average length of nap for three groups of children of different age levels.
2. Average time taken in going to sleep.
3. Percentage of days present, naps were taken.
4. Percentage of children present

who took naps on each day of the week.

5. Average length of nap for each day of the week.
6. Sex differences if any, in length of nap and time taken to go to sleep.
7. Sleeping positions most frequently taken.
8. Possible relationships between:
 - a. Time taken in going to sleep and length of nap.
 - b. Average length of nap and the possible number of naps (i.e. days present).
 - c. Average length of nap and number of days present.
 - d. Average length of nap and number of days on which the subjects were awakened by the teacher.
 - e. The time taken to go to sleep and the number of days the subjects were awakened by the teacher.
 - f. Temperature of sleeping room and length of nap.

PROCEDURE

The observer kept records during the afternoon nap for each child, as follows:

1. Time in bed.
2. Time asleep.
3. Time awake.
4. Unusual occurrences such as elimination or defecation, coughing, masturbation.
5. Temperature of the sleeping room.
6. Weather conditions.

In addition to these records the observer kept running notes on posture, change of posture, mouth open or closed, heavy or light breathing and any significant occurrences.

RESULTS

1. Average length of nap. The average length of nap for the age groups was:

	minutes
22-30 mos.	74
31-42 mos.	73
43-53 mos.	74
All subjects.	73½

2. Average length of time taken in going to sleep for the age groups was:

	minutes
22-30 mos.	38
31-42 mos.	36
43-53 mos.	41
All subjects.	38

3. Percentage of days present, naps were taken:

	per cent
22-30 mos.	83
31-42 mos.	80
43-53 mos.	82
All subjects.	82

4. Percentage of children present who took naps on each day of the week.

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
per cent	per cent	per cent	per cent	per cent
80	75	80	80	84

5. Average length of nap for each day of the week:

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
minutes	minutes	minutes	minutes	minutes
74	75	75	75	73

6. Sex differences were as follows:

AGE GROUP	AVERAGE LENGTH OF NAP		AVERAGE TIME TO GO TO SLEEP		PER CENT DAYS PRESENT WHEN NAP WAS TAKEN	
	Boys	Girls	Boys	Girls	Boys	Girls
	minutes	minutes				
22-30 mos.....	74		38		83	
31-42 mos.....	80	70	33	38	80	80
43-53 mos.....	77	69	43	39	87	72

7. Sleeping positions during nap. There were 244 records of posture during sleep made. 107, or 44 per cent of the total of these, recorded the child as lying on his right side; 77, or 31 per cent were on the left side; 38, or 16 per cent were on the stomach and 22, or 9 per cent were on the back. 203 records were made of mouth open

or closed. There were 149 or 73 per cent mouth open and 54 or 27 per cent mouth closed.

The correlation of length of nap with time of going to sleep and with temperature of room showed no significant relation. Age and sex differences were not marked.

ETHEL SCOTT.

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